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EFFECT OF STORAGE PERIOD OF COTTON SEEDS WITH FUNGICIDES ON SOME PHYSICAL, CHEMICAL AND PATHOLOGICAL CHARACTERS

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ABSTRACT

Seeds of Egyptian cotton, cv.86 were dressed with Rizolex, Monceren 25% and 47%, stored for 0.5 to 5.0 months, grown in naturally and artificially infested soils in conditioned and unconditioned greenhouse.

Laboratory studies showed that the oil acid value tended to increase by using seed dressing fungicides, and the lowest value was obtained from seed stored for one month, application of seed dressing produced a slight increase in the oil refractive. Results of conditioned greenhouse were best than those of the unconditioned greenhouse for the infested and non-infested soil. Monceren 47% was the best in unconditioned greenhouse for both infested or non-infested soil. While Rizolex gave the best results for most values of conditioned greenhouse for infested or non-infested soil. Stored treated seeds for 0.5 to 1.5 month before seeded in infested soil improved emergence percentage and induced control of seed decay, and there was inversely proportional between post-emergence infection and storage period. A negative significant correlation coefficient was found between pre-emergence damping-off and seedling vigor in both natural field soil and infested soil, in unconditioned greenhouse. While, a significant positive correlation was observed between seedling vigor and each of survival%, plant height and dry weight/plant in all conditions except in infested soil when seeded under conditioned greenhouse.

INTRODUCTION

Cotton seedlings damping-off is caused by a complex of seed and soil-borne organisms, which are found in all cotton-producing areas in Egypt. Although the populations of pathogenic agents differ from location to another, the pathogen most commonly involved in disease complex are *Rhizoctonia solani* (Rizk, 1980 and Mohamed, 1990), *Fusarium* spp. (Jackob, 1969 and Aly *et al*., 1996), *Macrophomina phaseolina* (Omar, 1999), *Pythium* spp. (Esia, 1983) and *Sclerotium rolfsii* (Kashaba, 1972).

Damping-off occurs as pre-emergence and post-emergence. Seedling root rot may also occur (Watkins, 1981). Losses caused by damping-off vary from one location to another and from year to year.

Replanting, poor stands, and seedling development and weed competition ultimately affect plant maturity, fiber quality and seed cotton yield (Kappelman, 1977). Thus, the widespread use of seed dressing fungicides for controlling the disease has become indispensable under Egyptian conditions (Eisa *et al*., 1987, Aly *et al*., 1992, Eisa *et al*., 1992, Drummond and Savoy, 1996).

Storing of cotton seeds dressed with fungicides may affect the efficiency of treatment and viability of treated seeds (Eisa *et al*., 1987, Carvalho *et al*., 1989).

Kanawade *et al*. (1986) reported that the reduction in germination values was lower for gin-run and acid-delinted cotton seeds stored for 12 months in a jute bag. The moisture content of acid-delinted cotton seeds was higher than gin-run cotton seeds. Packing material (cotton, polyethylene, moulded plastic jar and jute bag) had no effect on germination.

Seeds with 16% moisture content lost viability more rapidly than those with 8% moisture content. Seed treatment and storage period effect depend on moisture content. Cold storage maintained higher seed quality than storage at ambient conditions (Hasan, 1995).

The objectives of the present study were to study effects of storage period on efficiency of seed dressing fungicides and on viability of treated seeds.

MATERIALS AND METHODS

Three fungicides were used for dressing cotton seeds of cv. Giza 86 at 15 days intervals up to 5 months. Rizolex T50% (tolclofos-methyl:O,O-dimethyl-O-(2,6-dichloro-4-methylphenyl) phosphorothoate) + thiram (TMTD): Bis (dimethylthio-carbamonyl) disulfide, Monceren 25% (4-chlorphenyl)-N-phenylurea (C.A.) and Monceren 47% (6-chloro-3-pyridinyl). The fungicides were used at a rate of 3 g/kg seeds using Triton-B, as a sticker, treated seeds were left 24 hours to dry before storing, then packed in paper bags kept at room temperature. The storage periods experiment was conducted from August 1999 through December 1999. Treated seeds were packed in paper bags, kept at room temperature, which ranged from 32 to 17.9 and relative humidity ranged from 47% to 52%.

Laboratory experiments:

Treated seeds of cv. G-86, stored for 1, 2, 3, 4 and 5 months, were chosen to determine the effect of storage period on some oil properties such as acid value and refractive index in oil extracted from stored cotton seeds. This study was carried out in the laboratory of Special Food and Nutrition Unit, Food Technology Research Institute, Agric. Res. Center.

Greenhouse experiments:

The experiment included eleven storage periods and 3 fungicides. Five replicates were used for each treatment. Treated seeds were sown at the rate of 10 seeds/pot (15 cm in diameters). This experiment was carried out in naturally and artificially infested soils. The artificially infested soil was autoclaved and then infested with pathogenic isolates of *Rhizoctonia solani*, *Macrophomina phaseolina*, *Sclerotium rolfsii* and *Pythium* spp. Fungal inoculum taken from one-week old culture on PDA, was aseptically introduced into autoclaved sorghum grain medium in 500 ml glass bottle and allowed to colonized sorghum for 3 weeks and pots were kept under two temperature regimes, i.e. conditioned greenhouse (by heating system only) where maximum temperature was (26-30^{o}C) and minimum temperature was

(18-24°C) and in unconditioned greenhouse where max. was 15.5-27°C and min. was (9-18°C).

The experiment was carried out from 17/1/2000 through 1/2/2000. Data were recorded on pre-emergence damping-off, post-emergence damping-off at 15 and 35 days after sowing, respectively. Healthy survivals percentage plant height, dry weight/plant and seedling vigor were also recorded.

The seedling vigor (Pinckard and Melville, 1975) was estimated as an improved method of evaluating cotton seed treatment.

Seedling growth parameters such as plant height, fresh and dry weights were estimated from ten representative plants which were chosen at random for each treatment.

Data were statistically analyzed. The differences between means were tested by least significant difference (LSD) method (Sendecor and Cochran, 1967).

Correlation coefficients among variables in infested soil in each conditioned and unconditioned greenhouse were also calculated (Sendecor and Cochran, 1967).

RESULTS AND DISCUSSION

1. Laboratory experiments:

*** Chemical properties of oil extracted from stored cotton seeds dressed with fungicides:**

Seed Oil Properties: Application of seed dressing produced a slight increase in the oil refractive index for all treatments over those of the control (untreated seed) (Table 1).

The highest refractive index (1.4748) was obtained from both seeds treated with Monceren 25% and stored for 5 months or seed treated with Monceren 47% and stored for 4 months.

Seed Oil Content: The oil acid value tended to increase by using seed dressing fungicides, Monceren 25% gave the highest value. The lowest acid value was obtained from seed stored for one month.

In general, either the lowest oil refractive index and the lowest oil acid value desirable characters.

The acid value was in agreement with those reported by Farge *et al*. (1981), Basyony *et al*. (1989) and Hafez *et al*. (1996). The increase in acid value gradually increased over the storage periods, until it reached the maximum value after six months of storage.

The fungi produced lipase besides the seed lipase, which hydrolyzed the triglycerides to glycerol and fatty acids, the glycerol was consumed at first, Christensen (1967).

Hafez *et al*. (1996) reported that a moisture content in soybean permits invasion during storage followed by a decrease in germination percentage and increase in acid value of the seeds.

Table (1): The effect of some oil properties (acid value and refractive index) in oil extracted from stored cotton seeds of different periods.

Treatments	Free fatty acid (Acid value)	Refractive index
Stored seeds for 5.0 months:		
Dressed with Rizolex	4.14	1.4733
Dressed with Monceren 25%	3.90	1.4748
Dressed with Monceren 47%	3.49	1.4729
Stored seeds for 4.0 months:		
Dressed with Rizolex	3.72	1.4730
Dressed with Monceren 25%	4.29	1.4734
Dressed with Monceren 47%	3.58	1.4748
Stored seeds for 3.0 moths:		
Dressed with Rizolex	3.56	1.4745
Dressed with Monceren 25%	3.73	1.4736
Dressed with Monceren 47%	4.23	1.4736
Stored seeds for 2.0 months:		
Dressed with Rizolex	4.30	1.4736
Dressed with Monceren 25%	4.17	1.4738
Dressed with Monceren 47%	4.08	1.4745
Stored seeds for one month:		
Dressed with Rizolex	3.82	1.4733
Dressed with Monceren 25%	3.52	1.4734
Dressed with Monceren 47%	4.05	1.4746
Non-stored seeds:		
Dressed with Rizolex	3.97	1.4736
Dressed with Monceren 25%	4.53	1.4737
Dressed with Monceren 47%	3.49	1.4738
Untreated seeds:	3.53	1.4727

2. Greenhouse experiment:

A. Infested soil:

Data in Table (2) show that dressing cotton seeds with Rizolex, Monceren 25, 47% affect pre-emergence damping-off when the seeds were sown in infested soil and kept in unconditioned greenhouse. Pre-emergence damping-off was more severe when the experiment was carried out in unconditioned greenhouse compared with that in conditioned one. This may be due to the fluctuation between maximum and minimum temperature in the two temperature regimes.

Under the unconditioned greenhouse, the temperature of day and night was (15.5 – 27^{o}C). the maximum and minimum temperature in the conditioned greenhouse were (26 ± 4^{o}C) and (18 ± 4^{o}C), respectively. Monceren 47% significantly reduced pre-emergence damping-off compared to its lower concentration (25%).

In conditioned greenhouse, no significant difference was observed between treatments or their interaction with storage periods. Lack of significance between treatments in conditioned greenhouse may be due to

that conditions is optimum for cotton growth with the result disease reduction.

As to post emergence damping-off under conditioned or unconditioned greenhouse (Table 3), there were no significant effect due to treatments or storage periods. The interaction between fungicides and storing periods was not significant.

Table (2): Effect of storing cotton seeds dressed with fungicides on pre-emergence damping-off in infested soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	50.0	42.5	42.5	45.0	17.5	32.5	37.5	29.17
0.5	67.5	62.5	35.0	55.0	45.0	45.0	30.0	40.0
1.0	37.5	55.0	42.5	45.0	32.5	42.5	42.5	39.16
1.5	60.0	47.5	32.5	46.66	22.5	10.0	25.0	19.16
2.0	47.5	65.0	42.5	51.66	37.5	50.0	27.5	38.33
2.5	57.5	70.0	42.5	56.66	20.0	30.0	17.5	22.5
3.0	55.0	47.5	35.0	45.83	35.0	27.5	20.0	27.5
3.5	55.0	60.0	57.5	57.5	22.5	22.5	12.5	19.17
4.0	40.0	55.0	52.5	45.83	27.5	30.0	25.0	27.5
4.5	70.0	85.0	42.5	65.83	37.5	20.0	15.0	24.17
5.0	42.5	75.0	45.0	54.16	25.0	25.0	25.0	25.0
Mean	**52.95**	**60.45**	**42.72**		**29.32**	**30.45**	**25.22**	
L.S.D.		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**N.S.**	**N.S.**			**14.05**	**18.68**	
Seed treatments (T)		**10.88**	**14.48**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

Table (3): Effect of storing cotton seeds dressed with fungicides on post-emergence damping-off in infested soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	2.5	7.5	2.5	4.16	2.5	5.0	7.5	5.0
0.5	10.0	7.5	7.5	8.33	0.0	2.5	15.0	5.83
1.0	5.0	12.5	10.0	9.16	12.5	0.0	5.0	5.83
1.5	5.0	5.0	15.0	6.66	0.0	0.0	2.5	0.83
2.0	5.0	5.0	2.5	4.16	0.0	10.5	0.0	3.50
2.5	7.5	7.5	10.0	8.33	0.0	10.5	5.0	3.50
3.0	5.0	7.5	5.0	5.83	12.5	2.5	0.0	5.0
3.5	5.0	15.0	5.0	8.33	2.5	2.5	0.0	1.67
4.0	7.5	10.0	0.0	5.83	0.0	2.5	15.0	5.83
4.5	15.0	2.5	5.0	7.50	0.0	2.5	0.0	0.83
5.0	10.0	12.5	2.5	8.33	0.0	10.0	0.0	3.33
Mean	**7.05**	**8.41**	**5.90**		**2.73**	**4.40**	**4.54**	
L.S.D.		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
Seed treatments (T)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

Monceren 47% gave significantly higher stand (healthy survival %) when compared to that of Monceren 25% or Rizolex 50 when the experiment carried out under unconditioned greenhouse (Table 4). No significant effect was observed in healthy survival % between treatments under conditioned greenhouse.

Table (4): Effect of storing cotton seeds dressed with fungicides on healthy survival percentage in infested soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	47.5	50.0	55.0	50.83	80.0	62.5	60.0	67.5
0.5	22.5	30.0	57.5	36.67	55.0	52.5	55.0	54.17
1.0	57.5	32.5	47.5	45.83	55.0	57.5	52.5	55.0
1.5	35.0	47.5	52.5	45.0	77.5	90.0	72.5	80.0
2.0	47.5	30.0	55.0	44.17	62.5	32.5	72.5	55.83
2.5	35.0	25.5	47.5	36.0	80.0	52.5	77.5	70.0
3.0	40.0	35.0	60.0	45.0	52.5	70.0	80.0	67.5
3.5	40.0	25.0	37.5	34.17	75.0	75.0	87.5	79.17
4.0	52.5	35.0	47.5	45.0	72.5	67.5	60.0	66.66
4.5	15.0	12.5	52.5	26.67	62.5	77.5	85.0	75.00
5.0	47.5	12.0	52.5	37.33	75.0	65.0	75.0	71.66
Mean	**40.0**	**30.5**	**51.36**		**67.95**	**63.86**	**70.68**	
L.S.D		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**N.S.**	**N.S.**			**18.90**	**24.00**	
Seed treatments (T)		**11.80**	**15.70**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

B. Natural field soil:

The effect of storing cotton seeds dressed with Rizolex, Monceren 25% and 47% on cotton damping-off was also studied in naturally infested field soil (no infestation). From data in Table (5), it is clear that the inoculum level is enough for disease progress where pre-emergence was about 40%, and 25% when the experiment carried out in unconditioned and conditioned greenhouse, respectively. In conditioned greenhouse where conditions were optimum for cotton growth, a lower damping-off was observed compared to that in unconditioned greenhouse. No significant effect was obtained due to treatments or storing periods or their interaction.

In Tables (6 and 7), there were no significant effect in post-emergence damping-off (%) or healthy survival (%) due to either treatments or the interaction with period of storage up to 5 months.

A significant negative correlation was observed between pre-emergence damping-off and seedling vigor when stored dressed seeds were tested in natural field soil or infested soil (Table 8). The result was obtained in case of infested soil when the experiment carried out in unconditioned greenhouse. That means the higher the disease pressure during the pre- and post-emergence damping-off, the less seedling vigor would be. A significant positive correlation was observed between seedling vigor and each of survival %, plant height, dry weight/plant.

Table (5): Effect of storing cotton seeds dressed with fungicides on pre-emergence damping-off in natural field soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	50.0	37.0	35.0	40.66	22.5	27.5	25.0	25.0
0.5	52.5	40.0	52.5	48.33	20.0	25.0	32.5	25.83
1.0	42.5	40.0	40.0	40.83	20.0	42.5	22.5	28.33
1.5	47.5	55.0	52.5	51.66	15.0	25.0	27.5	22.5
2.0	30.0	52.0	42.0	41.33	15.0	30.0	15.0	20.0
2.5	32.5	40.0	35.0	35.83	17.5	15.0	25.0	19.16
3.0	52.5	52.5	37.5	47.5	35.0	22.5	22.5	26.66
3.5	40.0	40.0	42.5	40.66	27.5	20.0	27.5	25.00
4.0	37.5	37.5	37.5	37.5	20.0	27.5	30.0	25.83
4.5	35.0	30.0	37.0	34.0	25.0	27.0	15.0	22.5
5.0	35.0	35.0	35.0	35.0	22.5	27.5	27.5	25.83
Mean	**41.36**	**41.72**	**40.59**		**21.82**	**26.32**	**24.55**	
L.S.D.		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
Seed treatments (T)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

Table (6): Effect of storing cotton seeds dressed with fungicides on post-emergence damping-off in natural field soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	0.0	0.0	2.5	0.83	12.5	12.5	5.0	10.0
0.5	0.0	0.0	0.0	0.0	2.5	2.5	0.0	1.67
1.0	2.5	2.5	0.0	1.66	0.0	2.5	7.5	3.33
1.5	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.83
2.0	10.0	2.5	5.0	5.83	0.0	0.0	2.5	0.83
2.5	12.5	10.0	7.5	10.0	0.0	0.0	5.0	1.67
3.0	5.0	2.5	5.0	4.16	0.0	0.0	7.5	2.5
3.5	2.5	5.0	2.5	3.33	0.0	0.5	0.0	0.17
4.0	10.0	2.5	5.0	5.83	0.0	0.0	0.5	0.17
4.5	5.0	2.5	5.0	4.16	0.0	0.0	0.0	0.0
5.0	0.0	5.0	7.5	4.16	0.0	0.0	0.0	0.0
Mean	**4.32**	**3.23**	**3.64**		**1.34**	**1.64**	**2.77**	
L.S.D.		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**4.6**	**6.1**			**N.S.**	**N.S.**	
Seed treatments (T)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

Table (7): Effect of storing cotton seeds dressed with fungicides on healthy survival percentage in natural field soil under unconditioned (A) and conditioned greenhouse (B).

Storage period (month)	A				B			
	Rizolex	Monceren		Mean	Rizolex	Monceren		Mean
		25%	47%			25%	47%	
0	50.0	62.5	62.5	58.33	65.0	60.0	70.0	65.0
0.5	47.5	60.0	47.0	51.5	77.5	72.5	67.5	72.5
1.0	55.0	57.5	60.0	57.5	80.0	55.0	70.0	68.33
1.5	52.5	45.0	47.0	48.17	85.0	75.0	70.0	76.67
2.0	60.0	45.0	52.5	52.5	85.0	70.0	87.5	80.83
2.5	55.0	50.0	57.5	54.17	82.5	85.0	70.0	79.17
3.0	42.5	45.0	57.5	48.33	65.0	77.5	70.0	70.83
3.5	57.5	55.0	55.0	55.83	72.05	75.0	72.5	73.33
4.0	52.5	60.0	57.5	56.67	80.0	72.5	65.0	72.5
4.5	60.0	67.5	57.5	61.18	75.0	72.5	85.0	77.5
5.0	65.0	60.0	57.5	60.83	77.5	72.5	72.5	74.17
Mean	**54.32**	**56.86**	**55.60**		**76.82**	**71.59**	**72.73**	
L.S.D.		**0.05**	**0.01**			**0.05**	**0.01**	
Storage periods (P)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
Seed treatments (T)		**N.S.**	**N.S.**			**N.S.**	**N.S.**	
P x T		**N.S.**	**N.S.**			**N.S.**	**N.S.**	

This was true in all conditions except in infested soil when kept under conditioned greenhouse where the correlation was not significant between seedling vigor and each of survival % and plant height.

A significant positive correlation was observed between dry weight/plant and plant height in all conditions. Survival (%) was significantly negative correlated with pre- and post-emergence damping-off was only obtained in case of natural field soil when carried out under unconditioned greenhouse. These negative correlations imply that higher the disease pressure during the pre- and post-emergence stages, the less survivals would be. That is, even the plants which survived pre- and post emergence damping-off suffered from a subtle weakness which reduced seedling vigor, plant height, dry weight/plant. Similar correlations were obtained by Aly *et al*. (1996).

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تأثير تخزين بذرة القطن المعاملة بالمطهرات الفطرية على بعض الصفات الفسيولوجية والكيميائية والمرضية

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أجريت دراسات بالمعمل والصوبة لبيان الصفات الفسيولوجية والكيميائية والمرضية لبذور قطن صنف جـ 86 معاملة بالمطهرات الفطرية ريزولكس، مونسرين 25%، مونسرين 47% ومخزنة بعد المعاملة لفترات حتى خمسة شهور- وزرعت فى تربة حقل طبيعية وتربة ملوثة بالفطريات وذلك تحت ظروف صوبة مكيفة لبيان تأثير درجات الحرارة والتخزين. ويمكن تلخيص النتائج فيما يلى:

1. معاملة البذور بالمطهرات الفطرية زادت كل من محتوى الحامض للزيت (Acid value) ومعامل انكسار الزيت (oil refractive) وأقل قيمة لمحتوى الزيت كانت بالبذرة المخزنة لمدة شهر مع ملاحظة أن المرغوب هو التقليل من القيمتين.
2. كانت النتائج للدراسات المرضية لكل من الصوبة المكيفة والغير مكيفة كما يلى:

أ - كانت نتائج الصوبة المكيفة أفضل من الغير مكيفة.

ب - أعطى المونسرين 47% فى الصوبة الغير مكيفة أفضل النتائج وذلك فى حالة التربة المعدية والتربة الغير معدية، بينما كان الريزولكس هو الأفضل فى الصوبة المكيفة والتربة المعدية.

بالنسبة لكل من الإنبات والإصابة يعد الإنبات وقوة البادرات كان المونسرين 47% هو الأفضل بالنسبة للإصابة قبل الإنبات ونسبة البادرات السليمة وتساوى كل من الريزولكس والمونسرين 25% بالنسبة للوزن الجاف للبادرات.

ج - فى التربة الغير معدية، كان الريزولكس هو الأفضل بالنسبة لكل التقديرات فيما عدا الوزن الجاف فإن المونسرين 47% أعطى أعلى قيمة.

د - أظهرت دراسة الارتباط بين قوة البادرات ونسبة الإصابة قبل الإنبات وجد ارتباط معنوى سالب فى حالة التربة المعدية والغير معدية وذلك فى حالة الصوبة الغير المكيفة.

وفى نفس التجربة كان هناك ارتباط معنوى موجب بين قوة البادرة وكل من عدد البادرات السليمة وارتفاع البادرة والوزن الجاف للنبات فى كل ظروف التجربة ماعدا فى التربة المعدية عند زراعتها تحت ظروف الصوبة المكيفة.

Table (8): Correlation coefficients among variables used in evaluating performance of storing dressed cotton seeds on cotton damping-off in infested soil and natural field soil.

Soil	Greenhouse	Variable	Variable				
			X6	X5	X4	X3	X2
Infested	Unconditioned	1. Pre-emergence damping-off (%)	-0.820 a**	-0.215	-0.145	-0.907**	0.092
		2. Post-emergence damping-off (%)	-0.439*	-0.348	-0.173	-0.393*	
		3. Survival (%)	0.934**	0.293	0.234		
		4. Plant height	0.466**	0.648**			
		5. Dry weight/plant	0.546**				
		6. Seedling vigor					
	Conditioned	1. Pre-emergence damping-off (%)	-0.464**	-0.185	-0.157	-0.662**	0.244
		2. Post-emergence damping-off (%)	-0.159	0.199	0.096	-0.418*	
		3. Survival (%)	0.234	0.074	0.020		
		4. Plant height	0.172	0.821**			
		5. Dry weight/plant	0.399*				
		6. Seedling vigor					
Field soil	Unconditioned	1. Pre-emergence damping-off (%)	-0.579**	-0.177	-0.258	-0.866**	-0.523**
		2. Post-emergence damping-off (%)	0.263	0.342	0.286	0.063	
		3. Survival (%)	0.556**	0.055	0.121		
		4. Plant height	0.518**	0.414			
		5. Dry weight/plant	0.656**				
		6. Seedling vigor					
	Conditioned	1. Pre-emergence damping-off (%)	-0.593**	-0.125	-0.274	-0.872**	0.095
		2. Post-emergence damping-off (%)	0.037	0.411*	0.151	-0.505**	
		3. Survival (%)	0.465**	-0.123	0.135		
		4. Plant height	0.785**	0.760**			
		5. Dry weight/plant	0.703**				
		6. Seedling vigor					

a- Linear correlation coefficient (r) is significant at P ≤ 0.01 (x), P ≤ 0.05 (*) or P ≤ 0.01 (**).

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