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EFFECT OF INTERCROPPING SOYBEAN AND MAIZE ON SOYBEAN DAMPING-OFF DISEASE AND RELEVANT EFFECT ON THE RHIZOSPHERE MICROORGANISMS AND ANTAGONISTIC MICROBES

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ABSTRACT

The total numbers of actinomycetes, fungi and bacteria were lower in the single crop system of soybean or maize at Sakha and Itay El-Baroud Agriculture Research Stations. The most antagonistic microorganisms were selected and identified as *Trichderma viride; Bacillus subtilis* and *Streptomyces* sp. High numbers of total counted microorganisms were found in the system pattern (2 rows soybean: 2 rows maize) followed by (2 rows soybean: one row free, one row maize (2:1). The total counts of fungi and bacteria were higher under sole cropping condition in maize (soybean 0:4 maize), than sole cropping of soybean (soybean4:0 maize). However, actinomycetes showed some differences than this trend. Generally, the numbers were increased by time from seedling stage to flowering stage, and then decreased or become almost stable at mature stage. The antagonism between the pathogenic fungi and each of bioagents indicated that *B. subtilis* showed the highest reduction in linear growth followed by *T. viride* while, *Streptomyces* sp. showed the lowest reduction. *Bacillus subtilis* was the most effective bioagent in the reduction of pre-and post-emergence damping-off and increased survival plants percentages followed by *T. viride*, while the *Streptomyces* sp. was the least effective. Effect of soybean-maize intercropping system on soybean damping-off disease under field experiment indicated that the highest incidence was observed in 3:1 soybean: maize pattern while, 2:1 was the lowest disease incidence compared with other intercropping systems. The mono crop system of each soybean alone or maize alone resulted in the highest yield (kg/plot) in the two locations. While the yield of both soybean and maize in the four systems of intercropping *i.e.* (3:1, 2:2, 2:1 and 1:1) was higher as Land Equivalent Ratio (LER) in the system of 2:1compared with 3:1 system.

INTRODUCTION

To maximizing the net profit from the unit area of a land, intercropping has long been practiced by farmers. It was defined as planting of two or more crops simultaneously in the same field, at the same time by different types (Andraws and Kasssam, 1976). Soybean is known to be intercropped with many other crops including maize, cotton, sorghum, sugarcane, sweet potato and peanut (Crookston and Hill, 1979; Chan et al., 1980; FAO, 1980 and El-Gantiry *et al.,* 1993). Intercropping system of soybean with different recommended crops would be suitable way to increase the land productivity of the cultivated area in Egypt (El-Boray, 1978 and Shalaby *et al.,* 1997).Soybean intercropping may be affected by different factors, such as cropping pattern and soybean cultivars (Galal *et al.,* 1979 and Thompson *et al.,* 1976). Soybean is affected by different pests and diseases which decrease production of growing areas and intercropping systems may solve the problems. The example for this is intercropping soybean with maize, this planting system increased the occurrence of maize and soybean damping-off disease (Botros, 1988). Also, different intercropping systems of maize: soybean increased the pre-and post-emergence damping-off of soybean and maize (El-Gantiry *et al.,* 1993). The aim of this study is to evaluate the effect of different soybean and maize intercropping systems on the changes in the common rhizospheric microflora and yields of soybean and maize. Special reference was given to the effect on pre and post emergence damping-off of soybean as affected by the root infecting fungi.

MATERIAL AND METHODS

Rhizospheric microflora:

The rhizospheric microflora of sole and intercropping soybean and maize plants were studied after 25, 50, 75 and 100 days from sowing. Ten grams from soybean rhizosphere under different intercropping systems with maize, was added to flask containing 90 ml sterilized water, each flask was shacked for one hour. Suspension of each sample was subjected to a serial dilution to cover the range of 10^{-1} to 10^{-6} in sterile water then, 100μ of each of 10^{-4} – 10^{-6} dilution was spread onto each agarzed plate surface(Johansen *et al.,* 1960). Soil extract agar medium was used for isolation of bacteria, Starch nitrate agar medium for actinomycetes (Waksman and Lecheralier, 1961) and Potato dextrose agar (PDA) for fungi. The plates(four replicates) of each dilution were incubated at 25-28°C for 24-48 h for bacteria and 5-7 days for actinomycetes and fungi respectively then, examined for the total count and related to the used dilution. Separate colonies of each microorganism were selected and subculture on the previous media except for bacteria with which nutrient agar medium was used. The selected bacteria were initially classified according to their reaction to gram stain as well as their shapes.

The causal pathogens:

Purified isolates of *Rhizoctonia solani* (Kuhn), *Fusarium solani* (Mart.) Sacc. and *Macrophomina phaseolina* (Mouble) Ashby used in this study were obtained from culture collection of Legume and Forage Diseases Laboratory, Plant Pathology Institute, ARC. These isolates were previously evaluated for its pathogenicity to soybean plants and were pathogenic.

Antagonistic test of selected microorganisms:

The ability of selected microorganisms (actinomycetes, bacteria, and fungi) to inhibit the growth of the pathogenic fungi was studied. Petri dishes (9.0 cm in diameter) containing PDA medium were inoculated with equal discs (5mm) of each of *R. solani, F. solani* and *M. phaseolina* (7days old culture). The pathogenic fungi were inoculated at one side of the Petri dishes, whereas, the opposite side was inoculated with either disc of selected fungi, actinomycetes or with streak for bacteria. Control was prepared by the same manner for each treatment but without the antagonistic microorganism. Four replicates were used for each treatment. All treatments were incubated at 25°C. When mycelial growth covers the entire medium surface in the control treatment, plates were then examined and linear growth was recorded. The reduction in mycelial growth of each fungus was calculated. The most common antagonistic microorganisms were selected and identified as *Trichderma viride; Bacillus subtilis* (isolate B5) and *Streptomyces* sp.(isolate A1) according to Bergey's Manual of Systematic Bacteriology, 1984 for bacteria and according to morphological and physiological characters for actinomycetes (Cross,1989). Identification of the isolated fungi were carried out in the Legume and Forage Diseases Laboratory, Plant Pathology Institute, ARC, on the basis of their colonial and microscopical characteristics according to Barnett and Hunter(1972) and Domch *et al.*,(1980).

Greenhouse experiments:

Pot experiment was carried out to evaluate the effect of seed treatment with each of the three bioagents on the control of pre and post-emergence damping-off of soybean cv. Giza 82. The inoculum of the three pathogens *R. solani, F. solani* and *M. phaseolina* were grown on sterilized barley grains medium for 10 days at 25 ± 1°C. Then, each pathogen was added to previously autoclaved soil at the rate of 5% of soil weight. The infested soil of each pathogen was dispersed into four 20 cm pots, previously sterilized with 38% formalin for 15 minutes. Soybean seeds previously soaked in suspension of each of *Trichoderme viride* at 2 x 10^6 spore/ml, *Streptomyces* sp. At 2.5 x 10^8 spore/ml and *Bacillus subtilis* at 5 x 10^6 cfu/ml were sown in each pot, 10 seeds/pot. Non treated seeds were sown in infested soil to serve as check. Data were taken 25 and 45 days after sowing as percentage of pre-and post-emergence damping-off compared with the control treatment.

Field experiments:

A complete block design experiment was conducted under field conditions at Sakha and Itay El-Baroud Agriculture Research Stations in season 2004 under the stress of naturally infested soil. Soybean cv. Giza 82 was grown in this experiment either alone or intercropped with maize cv. 310. Sex treatments were compared in plots with four rows 3.0 m long (plot size 3.0 m x 2.4 m), and four replicates for each treatment. The treatments were as follows:

Treatment No.	No. of rows		System
	Soybean	Maize	
1	4	0	4:0
2	3	1	3:1
3	2	2	2:2
4	2	1	2:1
5	1	1	1:1
6	0	4	0:4

Four seeds / hill of soybean and 2 seeds / hill of maize were sown in one edge of each row with 30 cm between hills. Sown of soybean was simultaneously with the date of maize sown. All fertilizer, weed management and irrigation recommendations were followed. Pre and post emergence damping-off were recorded 25 and 45 days after planting as percentages.

Yield estimation:

The yield of each treatment was obtained at maturity of each crop, about 120 days from sowing of maize and 100 days for soybean at each location.

Land equivalent ratio (LER):

LER was determined according to De Wit and Den Bergh (1965) and has become common practiced in intercropping studies by Willey (1985).

L soybean= (intercropping yield of soybean/solid yield of soybean)

L maize= (intercropping yield of maize /solid yield of maize).

LER = L soybean + L maize.

Where LER is significant (more than 1) over yielding has occurred. When LER = 1, there has been an expected additive response of individual component, or if one has yielded poorly another has compensated by producing relatively more. When LER is less than 1 the intercropped system has failed.

RESULTS

1. Rhizospheric studies:

The total number of actinomycetes, fungi and bacteria were presented in Tables (1, 2 and 3). Results (Table, 1), indicated generally that the actinomycetes was lower in numbers in the single crop system for either soybean or maize alone at both locations, Sakha and Itay El-baroud. The same trend was also true for both fungi and bacteria, Tables (2 and 3). Also, highest numbers of the three counted microorganisms were found in the system pattern (2:2) after 75 days from sown being 28, 89 at Itay El-Baroud and 110 colonies at Sakha for actinomycetes, fungi and bacteria respectively. Followed by (2:1), and (1:1) system patterns. Generally, the numbers were increased by time from seedling stage (25 days after sowing) to flowering stage (75 days), and then decreased or become almost stable at mature stage (100 days).Under sole cropping systems, the total counts of fungi and bacteria were higher after 75 days at Itay El-Baroud under sole cropping condition in maize (0:4, recorded 42 and 70 respectively), than sole cropping of soybean (4:0, being 35 and 50 colonies respectively). However, actinomycetes showed some differences than this trend, Tables (1, 2 and 3).

Table(1) : Effect of soybean-maize intercropping system on total count of actinomycetes at different growth stages of soybean cv. Giza 82 under field conditions of two locations.

Cropping system No. of rows soybean :maize	Total count of actinomycetes x 10^5 after sowing (days) at							
	Sakha				Itay El-Baroud			
	25	50	75	100	25	50	75	100
4:0	2	8	10	11	2	9	10	8
3:1	6	9	12	11	4	8	13	11
2:2	13	17	22	20	12	20	28	24
2:1	7	12	17	16	6	11	16	15
1:1	10	16	23	22	7	18	25	26
0:4	3	6	6	5	2	5	7	7

Table(2) : Effect of soybean-maize intercropping system on total count of fungi at different growth stages of soybean cv. Giza 82 under field conditions of two locations.

Cropping system No. of rows soybean: maize	Total count of fungi x 10^4 after sowing (days) at							
	Sakha				Itay El-Baroud			
	25	50	75	100	25	50	75	100
4:0	16	18	35	28	14	23	35	30
3:1	39	46	47	45	19	35	42	37
2:2	60	71	79	73	76	81	89	76
2:1	55	72	78	52	48	69	72	60
1:1	58	63	68	62	38	49	54	52
0:4	27	32	37	36	18	31	42	38

Table(3) : Effect of soybean-maize intercropping system on total count of bacteria at different growth stages of soybean cv. Giza 82 under field conditions of two locations.

Cropping system No. of rows soybean : maize	Total count of bacteria x 10^6 after sowing (days) at							
	Sakha				Itay El-Baroud			
	25	50	75	100	25	50	75	100
4:0	20	42	48	45	22	45	50	47
3:1	40	50	57	56	36	42	53	50
2:2	93	104	110	96	76	89	95	86
2:1	66	85	95	96	79	96	98	78
1:1	68	85	92	78	59	82	96	84
0:4	33	45	62	62	32	54	70	67

2. Antagonistic testes:

The antagonistic effect between the soybean-emergence damping-off fungi, *F. solani, R. solani* and *M. phaseolina* and each of the selected microorganisms was studied as the percentage of reduction in linear growth of the pathogenic fungi. Results in Table(4) indicated that *B. subtilis* (isolate B5) showed the highest reduction in linear growth being 66.7,72.2 and 84.4% on *F. solani ,R. solani* and *M. phaseolina* followed by *T. viride* being 60.0,63.3 and 68.9 % respectively. The most effectve Streptomyces isolate was isolate A1 given reduction % 42.0, 38.9 and 48.8 % for the same fungi respectively.

Table (4): Effect of the tested bioagents on the linear growth of *Fusarium solani, Rhizoctonia solani* and *Macrophomina phaseolina* on PDA medium after 7 days incubation at 25°C.

Isolates Nos.		Selected microorganisms	*F. solani*		*R. solani*		*M. phaseolina*	
			Linear growth (mm)	% reduction	Linear growth (mm)	% reduction	Linear growth (mm)	% reduction
Actino-mycetes	A1	Gray,nondiffusable pigment	52.0	42.2	55.0	38.9	47.0	48.8
	A2	White,nondiffusable pigment	90.0	0.00	90.0	0.00	90.0	0.00
	A3	Reddish white, produce diff.pig.	75.0	16.7	82.0	8.9	79.0	12.2
Bacteria	B1	White, slimy, round, G^+	90.0	0.00	90.0	0.00	90.0	0.00
	B2	Reddish yellow.Irregular ,G^-	49.0	45.6	55.0	38.9	58.0	35.6
	B3	White creamy, round, G^-	71.0	21.1	80.0	11.1	67.0	25.6
	B4	Whitish yellow,irregular, G^+	90.0	0.00	90.0	0.00	90.0	0.00
	B5	White creamy, round , G^+	30.0	66.7	25.0	72.2	14.0	84.40
Fungi	F1	*Aspergillus niger*	74.0	17.78	70.5	21.67	69.5	22.78
	F2	*A. flavus*	64.5	28.33	69.0	23.33	67.0	25.56
	F3	*Trichoderma viride*	36.0	60.0	33.0	63.3	28.0	68.90
	F4	*T. harzianum*	73.0	18.9	62.0	31.1	57.0	36.7
	F5	*Alternaria* sp.	57.0	36.67	57.5	36.11	61.5	31.67
	F6	*Rhizopus* sp.	52.0	42.22	58.5	35.0	64.5	22.33
Control			90.0	-	90.0	-	90.0	-

3. Greenhouse experiments:

Data in Table (5) show that there is a significant difference between the tested bioagents in the reduction of pre-and post-emergence damping-off and increased of survival plants percentages. *Bacillus subtilis* was the most effective bioagent as survival plants showed high counts (59.3%), followed by *T. viride* (55.5%), while the *Streptomyces* sp. was the least effective (42.9%) for *F. solani* as an example. The same trend was also true for *R. solani* and *M. phaseolina*, Table (5).

4. Field experiment:

Effect of soybean-maize intercropping system on soybean damping-off disease: Effect of maize intercropping cv.310 on pre- and post-emergence damping-off of soybean cv. Giza 82 is presented in Table(6). Data show that the percentage of pre-emergence damping-off at Sakha location was 12.7% in the plots with 4 rows soybean alone. The highest incidence was observed in 3:1 soybean: maize pattern while, 2:1 was the lowest disease incidence compared with other intercropping systems. However, the differences between the treatments were not significant in pre and post -emergency damping-off at Sakha and Itay El-Baroud respectively. Post-emergence damping-off was reduced significantly from 2.5% and 2.3 % in the plots 1:1 and 3:1 soybean: maize to 1.3 %, 1.2% and 1.0 % in the plots with 2:2, 2:1 and 4: 0 soybeans: maize respectively. On the other hand at Itay El-Baroud location significant increase of pre-emergence damping-off being 12.7 % in the plots with 4 rows soybean alone increased to 18.6 % in the plots with 3:1 soybean: maize system. Meanwhile, post-emergence damping-off was increased from zero % to 2.1 %for the same treatments (4 rows soybean alone and 3:1 soybean: maize respectively).The 2:1 or 2:2 soybean: maize gave the lowest post-emergence damping-off 1.4% and 1.4% Table (6).

Table (5): Effect of seed soaking of soybean cv. Giza 82 with different bioagents on pre-and post emergence damping-off caused by *Fusarium solani, Rhizoctonia solani* and *Macrophomina phaseolina* under greenhouse conditions.

Bioagents	Damping-off %								
	F. solani			*R. solani*			*M. phaseolina*		
	Pre	Post	Surviv	Pre	Post	Surviv	Pre	Post	Surviv
Trichoderma viride	30.7	13.8	55.5	34.3	15.5	50.2	38.2	17.7	44.1
Bacillus subtilis	28.2	12.5	59.3	31.3	13.5	55.2	33.8	15.4	50.8
Streptomyces sp.	41.3	15.8	42.9	43.2	18.3	38.5	46.5	18.3	35.2
Control	52.3	21.5	26.2	53.8	22.3	32.9	55.7	23.5	20.8
L.S.D at 5%	2.7	1.6	1.5	2.5	2.2	2.8	2.3	2.5	2.3

Table (6): Effect of soybean-maize intercropping system on pre-and post-emergence damping-off of soybean cv. Giza 82 under Sakha and Itay El-Baroud field conditions.

Intercropping system No. of rows. soybean : maize	Damping-off % of soybean seedlings at			
	Sakha		Itay El-Baroud	
	Pre	Post	Pre	Post
4:0	12.7	1.0	12.7	0.0
3:1	16.4	2.3	18.6	2.1
2:2	14.6	1.3	15.2	1.4
2:1	13.7	1.2	13.9	1.4
1:1	14.8	2.5	15.7	1.8
0:4	-	-	-	-
L.S.D at 5%	N.S	0.47	1.56	N.S

5. Effect of soybean-maize intercropping system on yield (kg/plot) and Land Equivalent Ratio (LER) under field conditions:

Results in Table (7) indicated that the mono crop system of each soybean alone or maize alone resulted in the highest yield (kg/plot) in the two locations. Soybean alone showed 1.5 and 1.4 kg/plot, while maize alone showed 9.11 and 9.85 kg/plot at Sakha and Itay El-Baroud, respectively. While the yield of both soybean and maize in the four systems of intercropping i.e. (3:1, 2:2, 2:1 and 1:1) was higher as LER in the system of 2:1 showing 1.2 and 1.31 at Sakha and Itay El-Baroud compared with 1.14 and 1.13 with 3:1 system , at the two locations, respectively. However, it should be mentioned that the yield of both crops is higher in general since the value of LER was higher than one , indicating that soybean –maize intercropping system is successful under the selected systems especially the system of (2:1) and (2:2) . So, it is not only the number of plants/feddan which may affect the yield but also other yield components should be considered.

Table (7): Effect of soybean-maize intercropping system on yield (kg/plot) and Land Equivalent Ratio (LER) under field conditions at Sakha and Itay El-Baroud during season 2004.

Intercropping system soybean : maize	Sakha					Itay El-Baroud				
	Soybean yield Kg / plot	L Soybean	Maize yield Kg/ plot	L maize	LER	Soybean yield Kg / plot	L Soybean	Maize yield Kg/ plot	L maize	LER
Monocrop	1.5	-	9.11	-	-	1.4	-	9.85	-	-
3:1	1.3	0.87	2.47	0.27	1.14	1.2	0.86	2.65	0.27	1.13
2:2	0.9	0.60	5.22	0.57	1.17	1.0	0.71	5.13	0.52	1.23
2:1	1.1	0.73	4.27	0.47	1.20	1.1	0.79	5.17	0.52	1.31
1:1	1.0	0.67	4.34	0.48	1.15	0.8	0.57	5.81	0.59	1.16
L.S.D at 5%	0.20	-	1.69	-	-	0.25	-	1.33	-	-

DISCUSSION

Data obtained during study of rhizosphere of intercropping soybean-maize showed that total counts of microflora in soybean-maize rhizosphere were increased under intercropping conditions than solid cropping. Total microflora count increased after 75 days from sowing. However these counts were lower at seedling and at maturity stage. These differences on count of microflora might be due to the activity of root exudates of soybean and maize on the microflora increasing under intercropping conditions (Keswani *et al*., 1977). It may also contain some vitamins and growth regulators as mentioned by Botros, 1988 which increase the number and activity of soil microorganisms. Also, the increase of decomposing plant tissue under intercrop condition may increase the organic matter in the soil resulting in higher number of microorganisms in rhizosphere. Similar results were reported by Kaswani *et al.,* 1977; Abd El-Kader, 1983 and Shalaby *et al*., 1997.

The antagonistic effect of each of *B. subtilis, T. viride* and *Streptomyces* sp. on the main pathogenic fungi was studied under laboratory and greenhouse conditions. The obtained results indicated that all the tested bioagents were able to cause noticeable antagonistic action to the growth of *F. solani, R. solani* and *M. phaseolina*. The highest reduction of growth was caused by *B. subtilis* followed by *T. viride.* Meanwhile, the lowest reduction in the growth was recorded by *Streptomyces* sp. The antagonistic effect of the microorganisms may be due to production of antibiotics which causes malformed, ungerminated spores, or mycoparasitism and induction of phytoalexins and / or lytic enzymes, which inhibited spore germination (Wu, 1980 and Abd El-Moity, 1986). Hassanein and Mekhemar (2003) found that *Pseudomonas fluorescens* and *P. putida* caused significant reduction in mycelial growth of *Sclerotium rolfsii* on King's B medium. Also, reduced significantly pre and post emergence damping-off caused by *S. rolfsii* and increased survival plants individually or combined with *B. japonicum*. They added that generally, satisfactory results were obtained in case of co-inoculation by either *P. fluorescens* or *P. putida* in combination with *B. japonicum* in reducing damping-off by enhancing nodulation status and growth of soybean plant. Also, Abo-Zeid *et al.,* 2003 suggested that some products of microorganisms (*T. harzianum* and *B. subtilis*) stimulated plant growth and reduced population density of plant pathogens. Also, they found that using *B. subtilis* as seed coating against *R. solani* and *Fusarium* spp. decreased chickpea pre-and post emergence damping-off. El-Shafey *et al.,* 1985 found that *B. subtilis* is the most efficient isolate recovered from the soil and rhizosphere of maize plants antagonizing late wilt pathogen *Cephalosporium maydis*. Utkhede and Sholberg (1986) reported that most strains of *B. subtilis* are able to produce the antibiotics such as subtilin and bacillin which are able to inhibit the plant pathogens. In general, the obtained results are in agreement with those obtained by Aly (1978); Abd El-Kader (1983) and Camporota (1985). The role of root exudates of soybean and maize plants under intercropping may explain the higher percentage of pre- and post-emergence damping-off. These results are in agreement with Shalaby *et al., (*1997). They found that root exudates of maize and soybean under intercropping contain many amino acids and sugars which may result in stimulation the pathogenic fungi which attach soybean plant. Mohamed *et al*., (1991) and Arafa *et al.,* (1986). Heweidy *et al.,* (2003) found that seed treatment of two soybean cultivars using *Trichoderma harzianum* or *Bacillus subtilis* significantly reduced pre and post-emergence damping-off and consequently increased survival percentage and seed yield over the untreated control plants. The highest seed yield as indicated by Land Equivalent Ratio (LER), was obtained from 2:1 intercropping system, while the lowest yield resulted from 3:1 and 1:1 that may be attributed to increase in pre- and post-emergence damping-off, El-Gantiry *et al.,* (1993). Zahran (1971) and Roguib *et al.,* (1973) attributed this reduction in seed yields to the reduction in seed yield per plant and number of pods per plant. However, it should be mentioned that the LER for any of the studied systems was higher than one, indicating the successful use of intercropping soybean: maize, taking in consideration that the highest LER were obtained from 2:1 and 2:2 which showed also lower pre and post emergence damping-off.

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تأثير نظام تحميل فول الصويا والذرة الشامية على مرض سقوط البادرات فى فول الصويا وعلاقتة بالكائنات الحية بالريزوسفير وتأثيرها التضادى

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أوضحت النتائج أن التعداد الكلى للأكتينوميسيتس والفطريات والبكتيريا كان منخفضاً فى نظام الزراعة المنفرد سواء فى فول الصويا أو الذرة الشامية فى كل من محطتى بحوث سخا وإيتاى البارود. كانت الكائنات الحية الدقيقة ترايكودرما فيردى وباسيلس ساتلس والإستربتوميسيتس هى الأكثر تأثيراً تضادياً. وقد لوحظ أن التعداد الكلى للكائنات الدقيقة كان مرتفعاً فى نظام التحميل (٢ خط فول صويا : ٢ خط ذرة شامية) يلية النظام (٢ خط فول صويا : خط ذرة شامية) . وجد أن التعداد الكلى للفطريات والبكتيريا كان مرتفعاً تحت ظروف نظام الزراعة المنفردة للذرة الشامية مقارنة بالزراعة المنفردة لفول الصويا. بصفة عامة فأن التعداد زاد مع تقدم عمر النبات إبتداءً من طور البادرة إلى مرحلة التزهير ثم إنخفض مع الوصول لمرحلة النضج. التأثير التضادى بين فطريات سقوط البادرات فى فول الصويا وإى من الكائنات المضادة أظهر أن البكتيريا باسيلس ساتلس كانت الإكثر تأثيراً فى خفض نمو الفطريات الممرضة يليها الفطر ترايكودرما فيردى ثم الأستربتوميسيتس ونفس التأثير على خفض نسبة حدوث مرض سقوط البادرات قبل وبعد الإنبات والنسبة المئوية للنباتات المتبقية. تأثير نظام التحميل على مرض سقوط البادرات تحت الظروف الحقلية أوضح أن اعلى معدل لحدوث المرض سجل فى نظام التحميل ٣ فول صويا : ١ ذرة شامية بينما كان النظام ٢ :١ هو الأفضل فى خفض معدل الإصابة مقارنة بباقى نظم التحميل. إيضاً فإن نظام الزراعة المنفردة لأى من فول الصويا أو الذرة الشامية أعطى أعلى كمية للمحصول فى كلاً من محطتى التجارب. فى حين أن محصول فول الصويا والذرة الشامية فى الأربعة نظم للتحميل أوضحت أن نظام التحميل ١:٢ كان الأكثر كفاءة مقارنة بالنظام ٣ :١.