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Effect of Soil Texture and Irrigation Water Quality on Peanut Seedlings Infection with *Rhizoctonia solani*

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Soil texture and quality of irrigation water as factors affecting the infection rates of peanut seedlings with *Rhizoctonia solani* were studied. *Aspergillus niger, Fusarium* spp., *Rhizoctonia solani* and *Macrophomina phaseolina* were prevalent over the collected rotted samples of peanut roots and fruits in frequencies of (12.0-27.2%). Results indicated that the highest rate of infection (62.67%) occurred in sandy soil, while sandy clay soil gave the lowest rate (53.33%). The highest infection rate (70.67%) was obtained when irrigation was carried out using ground water. However, irrigation with Nile River gave the least infection rate (46.67%). Laboratory experiment using Ca^{++} and Na^{+} ions confirmed the results obtained from the pot experiment irrigated with agricultural waste water which is considered reach in Ca^{++} and Na^{+} ions.

Keywords: Damping-off, irrigation water, peanut and soil texture.

Peanut (*Arachis hypogea* L.) is one of the important annual legume and oil crops in Egypt. Several diseases could be recorded during the growing season, causing great losses in pod yield. Soil and seed borne fungi could attack root, stem and pods causing qualitative and quantitative damages as well as increasing soil infection. Therefore, continuous growing of peanut plants in the same soil subjected the crop to infection with these pathogens under favourable environmental conditions.

Soil texture affected incidence of root and pod rot of peanut caused by several fungi, *i.e. Fusarium* spp*., Macrophomina phaseolina*, *Rhizoctonia solani* and *Aspergillus niger* as well as affected fungal growth in soil during peanut growing (El-Wakil, 1981and Ismail and Abd El-Momen, 2007). Also, His (1965) found that the finer – textured soils were reported to increase black root rot severity on peanut and soybean (Lockwood *et al*., 1970), as compared with disease severity on coarser-textured. Soil chemical properties such as high PH (Bateman, 1962) and soil chemical factors related to soil PH, including cation exchange capacity, base saturation and calcium or aluminium ion concentration (Meyer and Shew, 1991) increase disease severity. Recently, root and fruit diseases caused peanut decline (Ismail and Abd El-Momen, 2007). Attempts were made to decrease amount of losses by selecting for resistant cultivars (Jackson, 1962), soil treatment with fungicides (Abdel-Ghany *et al*., 1973) or applying fertilizers (Abdel-Gallel, 1977).

The analysis of water quality in some irrigation systems found that in 25% of system, water quality does not meet the requirements, which affected the increase in concentration of salt in the soil above the allowable level, precluding the organic agriculture. Besides the total amount and the content of certain pollutants from the salt, harmful and dangerous substances in the irrigation water often come from chemicals which are used in agriculture as pesticides and nutrients, and from the waste waters, or wastes deposited in the watercourses, as well as by the presence of certain microorganisms. Water quality and its hygienic safety exceptionally in vegetable irrigation is extremely important due to increased demand for healthy safe food, and water can transfer harmful microorganisms to the plant products, which may cause diseases to human such as *Salmonella* sp., *Escherichia coli, Cryptosporidium parvum* and others (Dragovic *et al.*, 2010).

In Egypt, the main fresh water source is the Nile River from which obtain a fixed amount of water 55.5 milliard m^3/ year. It is insufficient according to the increasing population and reclamation of new land demands. Egypt faces increasing competitive demands for that water. Some of the water that is re-used includes municipal waste water which must be applied in accordance with increasingly stringent regulation. Thus it is important for Egypt to turn waste water into an irrigation resource. The majority of municipal waste water estimated as 1.3 billion m^3 /annum (Abd El-Naim, 1995). Also, used of agriculture waste water for crop irrigation has been recognized as a potential water resource and as an auxiliary supply for plant nutrients (El-Sayed, 2005).

Rate of infection of peanut stem and root with *Rhizoctonia solani* was inversely proportional to the seedling age. However, calcium (Ca) content increased as the seedlings become older (El-Samra *et al*., 1994). Amendment of conductive soil with $CaCO_3$, and/or alfalfa meal reduced damping-off cucumber seedlings caused by *Pythium splendens* from 78 to 30, 44 and 11%, respectively, (Kao and Ko, 1986). Moreover, severity of tomato wilt caused by *Fusarium oxysporum* was increased by deficient calcium (Ca) nutrition after infection and decreased when the deficiency occurred before infection (Malcolm, 1965). The objective of the present study was designed to test the effect of soil texture and irrigation water quality on infection of peanut seedlings with damping–off disease caused by *Rhizoctonia solani.*

Materials and Methods

Isolation and identification of peanut root and pods rot fungi:

Survey of peanut root and pod rot diseases was carried out during the period from 2009 to 2010 growing seasons in different localities of South Tahrir, Behera Governorates. Collected samples of diseased peanut root and pods after harvest were washed with tap water. Small pieces of the diseased parts, were surface sterilized by immersing in 3% sodium hypochlorite solution for three minutes, rinsed several times in sterilized distilled water and dried between two sterilized filter papers , then placed on PDA medium in Petri-dishes and incubated at 22±1°C for 3 to 7 days. Hyphal tip or single spore of each the developing fungi was transferred to PDA medium. Inoculum of each purified culture was transferred into PDA slant and incubated at 25°C. The developed fungal growth was sub cultured and identified according to Hildeband (1938), Gilman, (1957) and Booth (1971). Stock cultures were maintained on PDA slant and kept in a refrigerator at 5°C for further studies.

Types of soil:

Soil samples were collected at surface layer (0-20cm) from different areas located in Behera Governorate. The chemical analysis and some characters of soil used in experiments were carried out at the Unit of Soil, Water and Environment Research Institute, Agriculture Research Centre, Giza, Egypt. The characteristics of the analyzed soils used are shown in Table (1).

Table 1. Some characteristics of soil types used in the experiment

Parameter	Sandy soil No.1	Sandy clay soil	Sandy soil No.2
Particle- size distribution:			
Sand%	98.10	82.85	98.10
Silt %	1.20	5.65	1.4
Clay %	0.7	11.50	0.5
Textural class	Sandy	Sandy clay	Sandy
Saturation percentage %	20.0	23.0	20.0
Field capacity %	13.0	17.3	9.4
Organic matter %	0.04	0.09	0.05
pH (1:1)	7.6	8.1	7.8
EC (1:1, soil : water) dsm^{-1}	1.29	1.85	1.37
Soluble cations, meq/l :			
Calcium	2.99	5.16	3.15
Magnesium	1.54	3.78	2.05
Sodium	8.22	9.39	8.37
Potassium	0.25	0.22	0.2
Soluble anions, meq/l :			
Chloride	7.72	8.48	8.66
Available- k, mg/kg soil	23.82	59.48	29.22
Available- P, mg/kg soil	17.34	4.84	1.85
Total N, %	0.07	0.02	0.05

Types of irrigation water:

Three samples of irrigation water with different qualities were used in this study, Nile River water (Nasser Project), Agricultural waste water and ground water were collected from South Tahrir, Behera Governorate. Water samples were analyzed at Unit of Soil, Water and Environment Research Institute, Agriculture Research Centre, Giza, Egypt. Table (2) show the chemical composition of the different types of irrigation water used.

Peanut seeds preparation:

Certified peanut seeds (cv. Giza 6) obtained from the Agricultural Research Centre (ARC), Giza, Egypt, were sterilized by immersing in 3% sodium hypochlorite solution for 2 min. and rinsed several times in sterilized water, then dried with sterilized filter paper.

Table 2. Chemical composition of the three types of irrigation water

Parameter	Nile River water (NR)	Agricultural waste water (AWW)	Ground water (GW)
PH	7.35	7.50	7.62
EC,dSm^{-1}	0.37	0.93	3.24
Soluble cations, meq/l :			
Calcium	1.46	3.53	5.00
Magnesium	1.33	1.70	5.50
Sodium	0.84	3.25	20.30
Potassium	0.09	0.90	0.27
Soluble Anions, meq/l :			
Carbonates bicarbonates	1.89	3.25	6.00
Chloride	0.74	1.17	22.50
Sulphate	1.09	4.96	2.57

Greenhouse experiment:

Inoculation tests were carried out in plastic pots (20-cm-diam.). Plastic pots were sterilized by submerging in 5% formaldehyde solution for a few hours and left for ventilation. Soil was autoclaved at pressure of 1.5 kg/cm^2 for 90 min. and then left to be ventilated for 7 days before adding the inoculum. Inocula were prepared by growing the tested isolate of *Rhizoctonia solani* on Potato Dextrose broth medium in 250 ml conical flasks, each containing 50 ml of the medium. Inoculated flasks were incubated at 27°C for one week, after which fungal mats were collected, blended with tap water and used as inocula at the rate of 2.5g/kg of autoclaved soils. Surface sterilized seeds were planted at the rate of 4 seeds/pot and kept in the greenhouse.

Pot experiment was a factorial experiment in randomized complete block design with four replication for each treatment. The factors were soil texture as main treatment and type of irrigation water as sub main treatment. Percentages of pre- and post-emergence damping–off were recorded after 15 and 40 days of sowing for each treatment. After 45 days, seedlings of each pot were picked up and washed with tap water. They were left to air drying and then dried in oven at 65°C for 48 hrs or up to constant weight. The dried material was grounded in Wiley mill and stored for analysis. Samples of seedlings powder were analysis at Unit of Soil, water and Environment Research Institutes, Agriculture Research Centre, Giza, Egypt.

The collected data were subjected to analysis of variance (ANOVA) for effect of soil textures and types of irrigation water. The statistical analysis was conducted according to the methods of (Steel and Torrie, 1982).

Laboratory experiment:

In order to check the effect of some ions concentration on the growth of *R. solani*, calcium and sodium ions at the rate of 50, 100, 200, 300, 500 and 600ppm were tested. The isolate of *R. solani* was grown in 250ml/flask containing 50 ml PD broth supplemented with the proposed calcium and sodium ions concentrations and incubated at 28°C for two weeks. The mycelial mats were then harvested, filtered and dried between two filter papers and then weighted as a fresh weight, then dried in oven for 48 hrs at 65°C or up to constant weight and weighed. All treatments were repeated five times in completely randomized design. Linear growth of each treatment was recorded as mm after24 hrs at 25°C.

Results and Discussion

Fungi associated with root and fruits rot of peanut:

Different fungi were isolated from root and stem of peanut plants showing root rot, damping-off and fruits rot symptoms collected from newly reclaimed lands in Behera Governorate (Table 3). *Aspergillus niger, Fusarium* spp., *Rhizoctonia solani* and *Macrophomina phaseolina* were prevalent over the collected samples and recorded in frequencies of (25.3 & 27.2%), (20.3 & 18.2%), (14.0 & 13.8%) and (12.3 & 12.0%) for root and fruits, respectively. *Sclerotium rolfsii, Rhizopus stolonifer, Aspergillus flavus, Pythium debaryanum* and *Mucor* spp. were also recovered but at lower frequencies of (4.5 & 8.8%), (4.0 & 3.0%), (3.5 & 2.4%), (3.0 & 2.8%) and (2.5 & 2.2%) for root and fruits, respectively. These results are in harmony with those of many researchers (Garren, 1970; Atta-Alla *et al*., 2004 and Ismail and Abd El-Momen, 2007).

Table 3. Frequency of isolated fungi from peanut samples showing root-rot, damping-off and fruits rot symptoms[1]

Fungus	Fungal frequency (%) on plant part	
	Root and stem[2]	Fruits[3]
Aspergillus niger	25.3	27.2
Fusarium spp.	20.3	18.2
Rhizoctonia soloni	14.0	13.8
Macrophomina phaseolina	12.3	12.0
Sclerotium rolfsii	4.5	8.8
Rhizopus stolonifer	4.0	3.0
Aspergillus flavus	3.5	2.4
Pythium debaryanum	3.0	2.8
Mucor spp.	2.5	2.2
Other fungi	10.8	9.6

[1]Samples collected from different localities at Behera Governorate during 2009-2010 summer seasons
[2] Total samples = 400
[3] Total samples = 500

Greenhouse experiment:

Results presented in Table (4) indicate that the percentage of pre- and post-emergence damping-off of peanut plants grown in varied conditions of soil texture and quality of irrigation water.

a) Effect of soil texture:

Results in Table (4) show that tested *Rhizoctonia solani* isolate could incite the pre-and post- emergence damping-off in different soil textures in varying degrees. The highest value of peanut seedling infection occurred in sandy soil (Nos. 1&2). On the other hand, the lowest infection occurred in sandy clay soil. The mean percentages of pre-emergence damping-off reached 32, 24 and 28% for sandy soil (No.1), sandy clay and sandy soil (No.2), respectively.

The corresponding values for post-emergence damping–off were 30.67, 29.33 and 32.0%, respectively, meanwhile the total infection reached 62.67, 53.33 and 60%, respectively. It is clear that the total pre- and post-emergence damping-off was lowest in sandy clay soil than the other tested soils.

Table 4. Percentages of pre- and post- emergence damping-off and total infection of peanut seedlings with *R. solani* in response to soil texture and irrigations water quality

Soil texture	Irrigation water quality	Pre-emergence	Post-emergence	Total infection
Sandy soil (1)	Nile River	28	20	48
	Agric. waste water	32	28	60
	Ground water	36	44	80
Sandy clay	Nile River	20	24	44
	Agric. waste water	28	28	56
	Ground water	24	36	60
Sandy soil (2)	Nile River	24	24	48
	Agric. waste water	28	32	60
	Ground water	32	40	72
Mean effect of soil texture:				
Sandy soil (1)		32	30.67	62.67
Sandy clay		24	29.33	53.33
Sandy soil (2)		28	32.00	60.00
L.S.D 0.05		n.s.	n.s.	
Mean effect of irrigation water quality:				
Nile River		24.00	22.67	46.67
Agric. waste water		29.33	29.33	58.66
Ground water		30.67	40.00	70.67
L.S.D. 0.05		n.s.	5.02	

Available reports on the relation between soil type and diseases development are, somewhat, contradictory. *Macrophomina phaseolina* infection of crop plants are more sever on sandy soils than on heavy soils. His (1965) stated that charcoal rot of sorghum was more severe in sandy than clay soils. He attributed that as sandy soils have less water holding capacity and also become dry more quickly than the day soils. These soils are more variable in temperatures and generally warmer than clay soils during day- time. Also, these results are in agreement with those of El-Wakil (1981), El-Farnawany and Abdel-Nasser (1995). Also, Mahmoud *et al.* (2006) found that under greenhouse and field conditions all tested peanut cultivars varied in their susceptibility to infection by damping-off and peanut root rots. They added that cvs. Ismailia 1 and R 92, were the most resistant against infection by damping-off and peanut root-rot diseases and gave the highest percentage of survived plants, while cvs. Giza 5, Giza 4 and Georgia were the highly susceptible cultivars to the infection by damping-off and peanut root-rot.

b) Effect of water quality:

Results presented in Table (4) show that *R. solani* could cause pre-, and post-emergence damping-off infection to peanut seedlings at the different types of irrigation water in varied degrees. The highest percentage of pre- and post-emergence damping-off were observed in the case of using ground water (GW), but the lowest values were observed with Nile River (NR), the mean values of pre-emergence damping-off reached 24, 29.33 and 30.67% for NR, AWW and GW, respectively. Meanwhile, the corresponding values for post- emergence damping-off of peanut seedlings were 22.67, 29.33 and 40.0% and for the total infection were 46.67, 58.66, and 70.67% for RN, AWW and GW, respectively. Generally, the total infection percentage of peanut seedlings damping–off caused by *R. solani* showed low records in case of sandy clay soil irrigated with the agricultural waste water. The low infection records of *R. solani* in the case of using (R.N.) followed by (AWN) may be due to the higher salinity of water (EC= 0.37 and .93 dSm^{-1}, respectively), which increase the osmotic pressure of media and consequently causes the plasmolysis of fungal cells (El-Samra *et al*., 1994). Moreover, the increase of calcium or concentration (3.53 meq/l^{-1}) leads to significant decrease in disease severity (El-Samra *et al*., 1994). Also, the low percentage of infection was observed in case of sandy clay soil it may be due to the higher percentage of $CaCO_3$ (3.25 meq/l^{-1}) as stated by Kao and Ko (1986).

Data in Table (5) show the recorded fresh and dry weight and elements composition of shoot of peanuts plants as affected by soil texture and irrigation quality. It was clear that the highest fresh weight of shoots was recorded in the case of sandy clay soil 4.37g/plant, followed by sandy soil (No.1) 4.12 g/plant. However, the lowest weight of fresh shoot obtained when use sandy soil No.2 (3.73g/plant). Similar results were obtained in case of dry weight whereas 0.66, 0.91 and 0.60 gm/plant for sandy soil No.1, sandy clay soil and sandy soil No.2 were recorded, respectively. On the other hand, the highest weight of fresh and dry weight were observed in the case of using River Nil 4.25 and 0.85gm/plant, but the lowest values were observed as 3.8 and 0.63gm/plant, in case of using ground water, respectively. Data in Table (5) also, indicated the percentage of elements content in peanut seedlings. The highest values of nitrogen, phosphorus and calcium (2.85, 0.564 and 0.59 %) were obtained when peanut plants sown in sandy soil No.2 while, the lower values of N and Na (2.76 % and 0.60%) were found in sandy soil No.1. The irrigation water quality seems to affect the element content in seedling peanut. It is observed that agriculture waste water irrigation increased total content in N, Ca and Na (2.87, 0.57 and 0.88%) while, ground water gave highest value (0.569%) of P also, the highest value of K 1.78% was obtained when Nile River is used as irrigation water. Calcium affects the susceptibility of pectic substances to enzymatic

Table 5. Plant growth parameters and elemental composition of peanut seedlings infected by *R. solani* as affected by soil texture and irrigation water quality

Soil texture	Irrigation water quality	Fresh weight (g)	Dry weight (g)	Elemental composition (%)				
				N	P	K	Ca	Na
Sandy soil (No.1)	Nile River	4.37	0.82	2.99	0.468	1.71	0.54	0.50
	Agric. waste water	4.11	0.67	2.68	0.576	1.49	0.51	0.79
	Ground water	3.93	0.51	2.62	0.584	2.13	0.51	0.52
Sandy clay soil	Nile River	5.08	1.13	2.27	0.474	1.40	0.47	0.62
	Agric. waste water	4.14	0.83	3.24	0.472	1.53	0.57	0.90
	Ground water	3.95	0.80	2.92	0.471	1.36	0.55	1.03
Sandy soil (No. 2)	Nile River	3.80	0.62	2.82	0.573	1.44	0.49	0.52
	Agric. waste water	3.70	0.60	2.68	0.466	0.45	0.64	0.96
	Ground water	3.70	0.58	3.04	0.653	1.32	0.63	0.57
Mean effect of soil texture:								
Sandy soil (No .1)		4.12	0.66	2.76	0.543	1.52	0.52	0.60
Sandy clay soil		4.37	0.91	2.81	0.472	1.49	0.50	0.85
Sandy soil (No.2)		3.73	0.60	2.85	0.564	1.40	0.59	0.68
L.S.D. 0.05		0.81	0.017	n.s.	0.07	0.28	0.098	0.11
Mean effect of irrigation water:								
Nile River		4.25	0.85	2.69	0.505	1.78	0.50	0.54
Agric. waste water		4.00	0.75	2.87	0.505	1.43	0.57	0.88
Ground water		3.80	0.63	2.86	0.569	1.60	0.56	0.71
L.S.D. 0.05		0.59	0.02	n.s.	0.07	n.s.	0.08	0.11

hydrolysis in which Ca inhibit the fungal polygalacturonase and had the effect on the substrate and not on the enzyme itself (McClendon and Somers, 1960). Also, various researchers have shown the importance of calcium rate and timing with relationship to yield of both runner and Virginia type peanut (Gricher *et al*., 2004 and Wiatrak *et al*., 2006). Furthermore, Garren (1964) reported that high rates of calcium added to soil in the form of gypsum ($CaSO_4$. $2H_2O$) up to 8.960 kg/ha effectively reduced pod rot. Further study of Hailock and Garren (1968) suggested that the calcium content of peanut pods was important in suppression of pod rot caused by *P. myriotylum*. They added that pods containing > 0.20% calcium had less disease than those containing < 0.15% of calcium. Sodium ion (Na^+) may play a role in peanut seedling resistance to damping- off, it may be due to the toxic effect of Na^+ ion on the fungal cells (El-Farnawany and Abdel-Nasser, 1995). This may be responsible for plant resistance against damping-off caused by *R. solani* in which agricultural waste water–treated seedlings had less infection Table (5). Porter and Adamsen (1993) found that concentration of sodium in groundnut tissues and soil, as well as the severity and incidence of early leaf spot, were influenced by water quality and method of irrigation. They added that mean Na levels were always higher in tissues of plants receiving sprinkle – applied deep – well water containing an average Na concentration of 220mg/litre. Also, soil Na was higher in plots receiving sodic water and mean percentages of diseased leaflets, defoliation and number of lesions/leaflet 25, 60 and 35% greater, respectively, in plant receiving sodic irrigation water than in plants receiving non-sodic water.

Laboratory experiment:

The effect of different concentrations of Ca^{++} and Na^{+} ions on tested *R. solani* linear growth was studied on PDA medium, meanwhile the fresh and dry weight of fungus was determined on potato dextrose liquid medium.

From the results presented in Table (6), it could be observed that Ca^{++} and Na^{+} ions stimulate the linear growth of *R. solani* grown on PDA media. Results proved that the low concentration of Ca^{++} and Na^{+} ions stimulated the growth of *R. solani* up to 50 ppm. However, the least rates of linear growth, fresh and dry weight of mycelium mat could be detected when concentration of 600 ppm for both Ca^{++} and Na^{+} ions was applied.

Table 6. Linear growth and fresh and dry weights of mycelium mate of *Rhizoctonia solani* grown on media supplemented with different concentrations of sodium and calcium ions

Concentration (ppm)	Sodium ion			Calcium ion		
	Linear growth* (cm)	Fresh weight (g)	Dry weight (g)	Linear growth (cm)	Fresh weight (g)	Dry weight (g)
Control	3.25	1.98	0.35	3.30	2.51	0.35
50	3.37	3.07	0.27	3.57	3.21	0.34
100	3.56	3.18	0.31	4.23	3.31	0.44
200	3.3	3.29	0.35	4.53	2.89	0.38
300	3.24	3.38	0.36	3.95	2.59	0.32
500	2.75	3.48	0.34	3.67	2.07	0.28
600	2.3	2.22	0.25	3.34	2.03	0.26
L.S.D 0.05%	0.45	0.47	0.02	0.41	0.49	0.04

* Data were recorded 24 hours after inoculation of tested media.

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تأثير قوام التربه ونوعية مياه الرى على إصابة بادرات الفول السوداني بفطر الريزوكتونيا سولانى

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أجرى عزل للفطريات التي تهاجم الفول السودانى بمراحل النمو المختلفة حيث وجد أن الفطر اسبرجلس نيجر وأنواع من الفطرفيوزاريوم والريزوكتونيا سولانى والماكروفومينا فاسيولينا أكثر تواجدا بنسب تتراوح ما بين (١٢.٠ و 7٢.٢%) لأعفان الجذور والثمار على التوالي. تم دراسة تأثير كل من قوام التربة ونوعية ماء الرى على اصابة بادرات الفول السودانى بالفطر ريزوكتونيا سولانى ، حيث أوضحت النتائج ان أعلى نسبة إصابة كانت ٦٢.٦٢% في حالة التربة الرملية رقم ١ بينما كانت اقلها فى نسبة الاصابة ٣٣ و٥٣% فى حالة التربة الطينية الرملية وفى حالة الري بالمياه الأرضية كانت نسبة الإصابة ٧٠.٦٧% واقلها بنسبة ٤٦.٦٧% في حالة الرى بمياه النيل.

وقد اكدت الدراسة المعملية باستخدام ايونات الكالسيوم والصوديوم تقارب النتائج المتحصل عليها من تجارب الاصص التى تم ريها بمياه الصرف الزراعى حيث تعتبر نسبتها تسمح بنمو النباتات وتحد من انتشار ونمو الفطر تحت الدراسة. ولذلك نوصى باستخدام مياه الصرف الزراعى فى رى الفول السودانى واختيار التربة المنلسبة للحصول على اكبر عائد للمحصول كما ونوعا.