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MANAGEMENT OF ROOT DISEASES BY COMBINATION OF DIFFERENT SOILS WITH FERTILIZERS

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Abstract

A combination of fertilizers and different soil was assessed on growth indices and root diseases of okra (*Abelmoschus esculentus* L.) and cowpea (*Vigna unguiculata* L.). It was observed that sandy and sandy loam soil when mixed with fertilizers like urea, frutan and DAP at 0.1% w/w increases growth indices on okra and cowpea plant whereas urea and frutan at 0.1% w/w in clay soil completely reduced number of galls produced by *Meloidogyne javanica* (Treub) Chitwood in cowpea plant. Infection of *Fusarium* spp., and *Rhizoctonia solani* Kühn was completely reduced when all fertilizers were mixed with clay soil on both crop plants.

Introduction

The size of primary soil particles like sand, silt and clay expresses the soil texture (Donahue *et al.*, 1971). The rhizosphere and rhizoplane microflora is influenced by soil texture (Bitton *et al.*, 1974; Bahme & Schroth, 1978; Parke, 1971). It was reported that an optimum particle size of soil is important for the movement of each nematode species in soil (Wallace, 1958). The migration of plant-parasitic nematodes is influenced by the soil texture and pore size of soil. Juveniles of *Globodera rostochiensis* migrate towards potato plant were highest in sandy soil, intermediate in loamy soil and lowest in clay soil (Rode, 1962). The soil texture may stimulate, inhibit or suppress the growth of soil-borne root infecting pathogens (Ali, 1992).

Fertilizers are generally applied to improve the crop yield, nutritional quality and aesthetic value of crops (Huber & Watson, 1970). The fertilizers not only having direct physiological effects on the plant growth but also affect the microbial activity of the pathogens and associated soil microflora (Curl & Rodriguezkabana, 1973). In field peas, the application of nitrogen plus phosphorus, phosphorus plus potassium or nitrogen plus phosphorus plus potassium were effective in reducing severity of root rot caused by *R. solani* and *Fusarium oxysporum* where a combination of nitrogen plus phosphorus plus potassium were used (Srihuttagum & Sivasithamparam, 1991).

This paper reports on the influence of different soil texture with fertilizers for the management of root-rot and root-knot diseases of cowpea (*Vigna unguiculata* L.) and okra plants (*Abelmoschus esculentus* L.).

Materials and Methods

Collection of materials: Three soil types viz., sandy, sandy loam and clay were obtained from different areas of Karachi. Fertilizers used for the study were purchased from the local market, which contains several essential micro and macro nutrients in their composition.

Table 1. Properties of different soil.

Properties	Sandy soil	Sandy loam soil	Clay soil
Sand %	74.7	60.6	15.6
Silt %	14.1	21.3	29
Clay %	11.2	18.1	55.4
pH	8.9	8.85	8.75
Fusarium spp/g soil	30000	18000	10000
Macrophomina phaseolina sclerotia/g soil	30	19	11
Rhizoctonia solani %	33.33	27.77	16.66

Screen house experiments: The soil used like clay, sandy and sandy loam soil were screened through a 2 mm aperture sieve to discard non-soil particles and mixed thoroughly. Pots (350 g/pot) were filled with three different type of soil. Physical properties and population of *R. solani* (Wilhelm, 1955), *M. phaseolina* (Sheikh & Ghaffar, 1975) and *Fusarium* spp., (Nash & Synder, 1962) g^{-1} of soil was assessed (Table 1). The soil was placed in 8 cm diam; plastic pots. Soil was mixed @ 0.01 and 0.1% w/w of three fertilizers like DAP, frutan and urea. Five okra (*Abelmoschus esculentus* L.) and cowpea (*Vigna unguiculata* L.) seeds were sown in each pots separately. Each treatment was replicated thrice and the pots were kept in a randomized complete block design in the screen house bench where soil was adjusted to 50% moisture holding capacity.

Culture preparation for root knot nematode: *M. javanica* (Treub) Chitwood was obtained from pure cultures maintained on roots of eggplants (*Solanum melongena* L.). The entire root system was dipped in water and soil was removed gently without detaching egg sacs. Eggs were extracted by vigorous shaking of infested roots in a 1% Sodium hypochlorite solution for three minutes. The resulting suspension was then passed through a range of different mesh sieves. The eggs collected on a fine sieve (400 mesh sieve) were washed in tap water to remove all traces of Sodium hypochlorite before use. Hatched juveniles of *M. javanica* were obtained by placing the eggs in sterile distilled water for 3-5 days at 28˚C. Number of eggs and larvae/ml of suspension were determined with the help of counting dish (Hussey & Barker, 1973).

Inoculation of root knot nematode: One week after seedling emergence, the roots were infested with 2000 freshly hatched juveniles of *M. javanica* by making three holes around the seedlings. Soil without fertilizers served as control. Each treatment was replicated thrice and pots were arranged in a completely randomized design in screen house of Department of Botany, University of Karachi and watered daily. After 8 weeks of nematode inoculation, plants were gently removed from pots and roots were carefully washed in running water. Galls per root system by *M. javanica* and plant growth indices were recorded.

Isolation of fungi from infected root: To determine the incidence of fungi, roots were cut into small segments (5 mm) and after surface sterilization in 1% $Ca(OCl)_2$ for 3 min, five such segments were plated onto potato dextrose agar (PDA, MERCK) plates supplemented with benzyl penicillin potassium salt (0.1 g/l) and streptomycin sulfate (0.2 g/l). The plates were incubated at 28˚C for 1 week and infection percentage of fungi was determined.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) followed by the least significant difference (LSD) test at $P = 0.05$ and Duncan's multiple range test to compared treatment means, using statistica software according to Sokal & Rohlf (1995).

Results

Effect on growth indices: Increase in growth indices of cowpea and okra plants was observed with the increase in fertilizer concentration. Sandy and sandy loam soil in combination with fertilizers like frutan and DAP at 0.1% w/w showed an increment in okra and cowpea plants (Table 2). Urea when applied to sandy loam soil at 0.1% w/w showed significant ($p<0.001$) increase in plant weight, root height and root weight of okra in contrast to control (Table 2). Frutan when amended in sandy loam soil significantly ($p<0.001$) increased the plant height of okra. However, sandy loam soil showed better results in increasing growth parameters followed by sandy and clay soil (Table 2). DAP and urea when mixed in all soil like sandy, sandy loam and clay soil showed increased growth indices in contrast to control soil (Table 2).

Effect on *M. javanica* infection: Number of galls produced by *M. javanica* were decreased on okra and cow pea when fertilizers were amended in clay, sandy and sandy loam soil. Urea and frutan at 0.1% w/w in clay soil showed complete reduction of *M. javanica* galls on cowpea plant ($p<0.001$) (Table 3). Few galls per root system were observed in cowpea and okra plant when clay and sandy loam soil was mixed with urea at 0.1% w/w (Table 3). However, urea and frutan were found better followed by DAP. Of the different soil used, clay soil was found to give better results followed by sandy loam and sandy soil in contrast to control.

Effect on root rot fungi: *Fusarium* spp., ($p<0.05$) and *R. solani* ($p<0.01$) were completely inhibited when all fertilizers were amended in clay soil on okra plant whereas on cowpea plant *R. solani* showed complete inhibition when clay soil was amended with all fertilizers ($p<0.01$) (Table 3). DAP and urea in both concentration like 0.01 and 0.1% w/w was found to completely reduce the infection of *Fusarium* spp., *R. solani* and *M. phaseolina* on cowpea and okra plants (Table 3).

Discussion

Fertilizers when mixed in sandy, sandy loam and clay soil reduced nematode infestation on cowpea and okra plants. Urea and frutan amended in clay soil at 0.1% w/w showed complete reduction of number of galls per root system of cowpea plant. Dabire & Mateille (2004) found that no nematodes survived in the clay soil as compared to sandy and in the sandy-clay soils where the population of nematode was multiplied. Siddiqui & Mahmood (1998) observed that tomato plants grown in pure sandy soil had the least galling and nematode reproduction whereas in a mixture of clay and sand of 1:3 supported highest galling and nematode reproduction, followed by 2:2 and 3:1 clay:sand ratio. It was found that DAP and urea at both concentrations like 0.01 and 0.1% w/w completely inhibited root infecting fungi on cowpea and okra plants. Our findings agreed with Tariq *et al*., (2008) where DAP and urea at 0.01 and 0.1% w/w mixed with *Avicennia marina* leaves powder showed complete suppression of *M. phaseolina* infection on roots of okra plants. Huber (1980) observed that control of root infecting fungi with the use of mineral fertilizers increase in tolerance level of plants with the development of thicker cuticle and cell wall or more sclerenchyma tissue with different nutrient regimes which has been correlated with the difficulty in penetration of pathogen. Siddiqui *et al*., (2000) found better control of root infecting fungi when urea was mixed with *Rhizobium* and *Trichoderma harzianum*.

Table 2. Effect of fertilizers in different soil on growth indices of okra and cowpea.

Treatments	Okra				Cowpea			
	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)
Sand (control)	13.9	0.71	7.13	0.77	22.83	1.17	8.88	0.41
Sand+ 0.01%DAP	16.3	0.76	9.36	0.84	28.16	1.3	13.81	0.54
Sand+ 0.1% DAP	20.56	1.14	10.9	1.27	52.97	2.5	15.45	0.66
Sand+ 0.01%Urea	17.4	1.12	10.46	1.53	28.72	1.49	11.63	0.63
Sand+ 0.1% Urea	21.23	1.4	16.26	1.65	30.31	1.72	16.13	0.73
Sand+ 0.01%Frutan	11.83	0.74	8.56	0.83	31.28	1.23	13.98	0.53
Sand+ 0.1%Frutan	16.26	1.24	10.23	1.14	34.09	1.46	18.08	0.72
Sandy loam (control)	12.9	1.14	8.86	1.12	19.92	1.46	6.51	0.41
Sandy loam + 0.01%DAP	19.1	1.23	12.26	1.23	30.23	1.44	10.29	0.44
Sandy loam + 0.1% DAP	20.6	1.37	15.23	1.31	38.36	1.55	14.08	0.52
Sandy loam + 0.01%Urea	17.4	1.74	12.2	1.27	29.21	1.44	11.47	0.48
Sandy loam + 0.1% Urea	18.23	2.41	22.23	1.7	35.18	1.8	34.92	0.52
Sandy loam + 0.01%Frutan	20.76	1.19	15.3	1.22	28.33	1.51	7.8	0.45
Sandy loam + 0.1%Frutan	25.13	1.34	11.33	1.25	33.32	1.54	15.28	0.65
Clay (control)	2.7	0.76	2.5	0.78	17.41	0.89	6.17	0.43
Clay + 0.01%DAP	8.33	0.86	5.6	0.62	17.54	1.5	5.53	0.54
Clay + 0.1% DAP	19.3	1.53	12.3	1.7	29.37	1.85	14.36	0.76
Clay + 0.01%Urea	4.13	0.41	3.43	1.42	20.18	0.92	8.98	0.57
Clay + 0.1% Urea	10.06	1.05	7.36	1.16	24.23	1.56	20.75	0.79
Clay + 0.01%Frutan	10.7	0.74	11.56	0.87	26.35	1.41	8.33	0.74
Clay + 0.1%Frutan	16.23	1.46	15.83	1.51	28.32	1.51	11.34	0.76
$LSD_{0.05\ (Treatment)}$	5.84	0.49	4.04	0.47	8.88	0.56	6.87	0.2
$LSD_{0.05\ (Soil)}$	3.82	0.32	2.64	0.31	5.81	0.37	4.49	0.13

Table 3. Effect of fertilizers in different soil on root infecting fungi and number of galls per root system of okra and cow pea.

Treatments	Okra				Cowpea			
	A	B	C	D	A	B	C	D
Sand (control)	100	100	44.44	120	100	66.66	100	70
Sand+ 0.01%DAP	33.33	55.55	0	68	77.77	33.33	88.88	30
Sand+ 0.1% DAP	0	0	0	63	33.33	0	44.44	26
Sand+ 0.01%Urea	100	44.44	33.33	73	66.66	66.66	66.66	40
Sand+ 0.1% Urea	66.66	0	0	62	44.44	0	55.55	32
Sand+ 0.01%Frutan	66.66	55.55	22.22	85	77.77	0	77.77	46
Sand+ 0.1%Frutan	44.44	33.33	0	53	55.55	0	55.55	34
Sandy loam (control)	100	66.66	77.77	67	100	66.66	77.77	62
Sandy loam + 0.01%DAP	66.66	0	33.33	40	77.77	33.33	55.55	38
Sandy loam + 0.1% DAP	33.33	0	0	31	0	11.11	26.66	32
Sandy loam + 0.01%Urea	33.33	66.66	33.33	38	77.77	44.44	0	36
Sandy loam + 0.1% Urea	0	33.33	0	28	0	44.44	0	28
Sandy loam + 0.01%Frutan	88.88	66.66	66.66	64	66.66	44.44	66.66	31
Sandy loam + 0.1%Frutan	33.33	0	33.33	62	66.66	0	0	26
Clay (control)	22.22	11.11	33.33	51	100	100	77.77	54
Clay + 0.01%DAP	0	0	0	42	66.66	0	66.66	48
Clay + 0.1% DAP	0	0	0	35	55.55	0	55.55	40
Clay + 0.01%Urea	0	0	0	20	100	0	0	47
Clay + 0.1% Urea	0	0	0	0	0	0	0	25
Clay + 0.01%Frutan	0	0	0	22	100	0	66.66	52
Clay + 0.1%Frutan	0	0	0	0	100	0	0	33
$LSD_{0.05(Treatment)}$	30.94	29.6	28.53	17.96	24.3	18.73	78.28	0.67
$LSD_{0.05(Soil)}$	20.25	19.4	18.67	11.75	15.9	12.26	51.25	0.44

*A= *Fusarium* spp., **B= *Rhizoctonia solani*, ***C= *Macrophomina phaseolina*, ***D= Number of galls per root system

Urea showed significant reduction in *M. phaseolina* infection on mung bean plants (Dawar & Ghaffar, 2003). Frutan and DAP amended with sandy and sandy loam soil caused significant increase in plant length on okra whereas urea with sandy loam soil at 0.1% w/w concentration caused significant increase in growth indices on okra plant. Nitrogen present in the fertilizer is absorbed by the plant which is utilized in protein synthesis and seed production whereas potassium is involved in many cellular functions including photosynthesis, phosphorylation, water maintenance, reduction of nitrates and reproduction. Potassium is also known to reduce *F. oxysporum* infection on tomato (Ellet, 1973) and *R. solani* infection on hemp (Pal & Choudhary, 1980). Sheikh *et al.*, (2006) found an increase in growth parameters of okra and mung bean plants where nursery fertilizers like flourish, frutan, NPK, urea and fish meal were used as seed dressing and soil drenching. Based on these results we conclude that fertilizers in combination with have the potential to be used for the reduction of root diseases and improve growth of okra and cowpea plants.

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