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THE EFFECT OF MANGROVES AMENDMENTS TO SOIL ON ROOT ROT AND ROOT KNOT OF POTATO (*SOLANUM TUBEROSUM* L.).

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S u m m a r y

Leaves, stem and pneumatophore of *Avicennia marina* and leaves and stem of *Rhizophora mucronata* were used as the organic amendments at 0.1, 1 and 5% concentrations in the control of root rot fungi like (*Fusarium* spp., *Rhizoctonia solani* and *Macrophomina phasoelina*) and root knot nematode *Meloidogyne javanica* on potato. In pot experiments, germination of seeds, shoot length, shoot weight, root length, root weight and number of knots were significantly increased when plant parts like leaves, stem and pneumatophore of *A. marina* and *R. mucronata* were used at 1 and 5% concentrations. There was a complete suppression in infection of *R. solani* and *M. phaseolina* when *A. marina* and *R. mucronata* were used at 5% concentration on potato. Maximum inhibition of knots of *M. javanica* was observed when powder made from mangrove plant parts was used at 1 and 5% concentrations. Powder from all plant parts, like leaves, stem and pneumatophore, was effective in suppression of root infecting fungi and root knot nematode.

Key words: Mangroves, control, root rot fungi, root knot nematode, potato

INTRODUCTION

Amendments provide energy and nutrients to soil, drastically changing the environment for the growth and survival of crops and micro-organisms (D r i n k w a t e r et al. 1995). Organic soil amendments are commonly used in the agricultural system to recycle nutrients and energy as well as to improve soil conditions for plant growth (H a d a r et al. 1992; M u c h o v e j and P a c o v s k y, 1997). Some organic amendments suppress soil-borne plant pathogens and several also control plant-parasitic nematodes (R o d r i g u e z - K a b a n a, 1986; A l i et al. 2001). In general, soil amendment with toxic plants suppresses plant pathogens directly by releasing toxic substances like phenols, and indirectly enhancing soil micro-organisms that inhibit phytopathogens, and also plant-parasitic nematodes (A l i et al. 2001; S h a u k a t et al. 2001).

The soil borne root-infecting fungus, *Macrophomina phaseolina*, is reported to produce charcoal rot of over 500 species of plants (S i n c l a i r, 1982). *Rhizoctonia solani* exists as active mycelium in the soil, attacks over 2000 species of plants (P a r m e t e r, 1970), and *Fusarium* species (B o o t h, 1971) are known to infect a wide range of host plants in different parts of the world. Soil borne root infecting fungi cause seed decay, root rot and stem rot of crop plants.

Root-knot nematodes *Meloidogyne* spp. are world wide in distribution and are known to attack a wide variety of crops (G o o d e y et al. 1965). Till now 70 species of *Meloidogyne* have been identified (L u c et al. 1988). Only 4 species like *M. incognita* (Kofoid & White) Chitwood, *M. javanica* (Treub) Chitwood, *M. arenaria* (Neal) Chitwood and *M. hapla* (Chitwood), are of major economic importance. The various species of *Meloidogyne* induce major morphological and physiological changes within roots. In nearly every crop yields and quality are reduced (S a s s e r, 1980). About 100 plants have been found to be infested with root-knot nematodes from different cultivated zones of Pakistan (M a q b o o l, 1988; Z a k i, 2000). Damage caused by root-knot nematode is much higher in tropical and sub tropical countries (T a y l o r and S a s s e r, 1978).

Pakistan has a coastline of about 1,000 km. The Indus River Delta extends over 250 km from Sir Creek at the Indian Border and Karachi in the west with about 250,000 ha of mangroves (K h a n, 1966; M i r z a et al. 1983). The predominant species of mangrove is *Avicennia marina*, whereas *Rhizophora mucronata* comprises less than 5% area (S a i f u l l a h, 1982). The mangrove plant parts are of various uses. Bark is used for tanning and dye. Leaves are the source of a black or chestnut dye (B u r k i l l, 1966). It is reported that mangrove is a folk remedy for angina, diabetes, diarrhea dysentery,

hematuria and haemorrhage (Duke and Wain, 1981). The aim of the present study was to determine the suppression of root rot and root knot nematode on potato (*Solanum tuberosum* L.) by dried powder of plant parts of *A. marina* and *R. mucronata*.

MATERIALS AND METHODS

Root rot fungi: Mangrove plant parts like leaves, stem and pneumatophore of *Avicennia marina* (Forsk.) Vierh and leaves and stem of *Rhizophora mucronata* Lamk were collected from Sonmiyani. The plant parts were washed, air dried and powdered in an electric grinder. Unsterilized sandy loam soil (sand, silt, clay; 70, 19 and 11% respectively) of pH 7.5-8.1 with moisture holding capacity (MHC) of 40% (Keen and Raczkowski, 1922), total nitrogen 0.077-0.099% (Mackenzie and Wallace, 1954), total organic matter 4.17-4.59% obtained from the experimental plots of the Department of Botany, University of Karachi, was mixed with powdered leaves, stem and pneumatophore of *A. marina* and leaves and stem of *R. mucronata* at concentrations of 0.1, 1 and 5%. The soil had natural infestation of 4-6 sclerotia/g soil of *Macrophomina phaseolina* as found by wet sieving dilution technique (Sheikh and Ghaffar, 1975), 3-5% colonization of *Rhizoctonia solani* on sorghum seeds used as baits (Wilhelm, 1955) and $8x10^6$ cfu/g soil of *Fusarium* sp., as assessed by soil dilution technique (Nash and Snyder, 1962).

The amended soil was placed in 8 cm diam. plastic pots @ 1 kg/clay pot and watered daily to facilitate the decomposition of the plant material. Ten days after amendment, 2 potato (*Solanum tuberosum* L.) seed tubers were sown in each pot. Treatments were replicated three times and the pots were kept in a randomized

Table 1
Effect of mangroves amendments to soil infected with pathogenic fungi on growth parameters of potato.

Avicennia marina					
Treatments	**Germination %**	**Shoot length (cm)**	**Shoot weight (g)**	**Root length (cm)**	**Root weight (g)**
Control	50.00	13.83	2.98	18.16	0.63
0.1% leaves	66.66 (33.32)	14.28 (3.25)	2.90 (2.68)	14.56 (19.82)	0.70 (11.11)
1% leaves	83.33 (66.66)	16.00 (15.69)	3.86 (29.53)	18.25 (0.49)	0.89 (41.26)
5% leaves	100.00 (100.0)	17.41 (25.88)	3.99 (33.89)	18.63 (2.58)	0.9 (42.85)
0.1% stem	66.66 (33.32)	21.00 (51.95)	5.09 (70.80)	18.30 (0.77)	0.65 (3.17)
1% stem	83.33 (66.66)	21.00 (51.95)	5.11 (71.47)	22.43 (23.51)	0.99 (57.14)
5% stem	100.00 (100.0)	22.25 (60.88)	5.51 (84.89)	22.83 (25.71)	1.01 (60.3)
0.1%pneumatophore	50.00 (0.00)	14.84 (7.32)	2.99 (0.33)	18.60 (2.42)	0.64 (1.58)
1% pneumatophore	66.66 (33.32)	19.46 (40.70)	3.90 (30.87)	18.91 (4.12)	0.65 (3.17)
5% pneumatophore	83.33 (66.66)	23.66 (71.07)	4.14 (38.92)	19.06 (4.95)	0.74 (17.46)
LSD0.05=	32.59	10.50	3.22	11.97	0.90
Rhizophora mucronata					
Control	66.66	9.81	1.94	10.6	0.34
0.1% leaves	66.66 (0.00)	10.18 (3.77)	1.81 (6.70)	11.05 (4.24)	0.37 (8.82)
1% leaves	100 (50.01)	11.41 (16.30)	2.63 (35.56)	11.24 (6.03)	0.43 (26.47)
5% leaves	100 (50.01)	12.38 (26.19)	3.35 (72.68)	12.72 (20.00)	0.53 (55.88)
0.1% stem	66.66 (0.00)	10.26 (4.58)	2.80 (44.32)	10.62 (0.18)	0.33 (2.94)
1% stem	83.33 (25.00)	12.21 (24.46)	2.83 (45.87)	10.95 (3.30)	0.38 (11.76)
5% stem	100 (50.01)	13.48 (37.41)	3.62 (86.59)	11.69 (10.28)	0.49 (44.11)
LSD0.05=	36.31	1.08	1.04	1.80	0.15

Parenthesis shows increase % as compared to control.

fashion on the screen house bench of the Department of Botany, University of Karachi, where soil was kept at 50% Water Holding Capacity (Keen and Raczkowski, 1922).

Plants were uprooted after 60 days of emergence and growth parameters in terms of plant height and fresh weight of shoot were recorded. To determine the incidence of fungi, one cm long root pieces, after washing in running tap water, were surface sterilized with 1% Ca $(OCl)_2$ and transferred on PDA plates supplemented with penicillin at 200 mg/l and streptomycin at 200 mg/l at 5 pieces per plate. Petri dishes were incubated at room temperature and after one week, infection of roots by root infecting fungi (Siddiqui et al. 1999) was recorded as follows:

Infection % = (Number of plants infected by fungus/Total number of plants) X 100

Root knot nematode: The roots of brinjal (*Solanum melongena*) infested with root knot nematode *M. javanica* were collected from the experimental plot of Department of Botany, University of Karachi. The roots were washed under running tap water and cut into small pieces, then dipped in 100 ml of 1% Ca $(OCl)_2$ in a bottle and the mouth was tightly closed, then shaken vigorously by hand for 5 min and the content was poured onto a 100 mesh sieve fitted over a 400 mesh sieve, the roots were washed under running tap water for 1 min, the residues from the 400 mesh sieve were transferred into a 250 ml beaker. Number of eggs and larvae/ml of suspension were determined with the help of a counting dish (Hussey and Barker, 1973). The population of pathogens in soil and experimental design were same as described in root infecting fungi.

Table 2

Effect of mangroves amendments to soil on infection % of *Fusarium* spp., *Rhizoctonia solani* and *Macrophomina phaseolina* on potato plant.

Avicennia marina			
Treatments	***Fusarium* spp.**	***Rhizoctonia solani***	***Macrophomina phaseolina***
Control	100.00	96.66	100.00
0.1% leaves	83.33 (16.67)	70.00 (27.58)	90.00 (10)
1% leaves	43.33 (56.67)	36.66 (62.07)	46.66 (53.34)
5% leaves	13.33 (86.67)	6.66 (93.10)	16.66 (83.34)
0.1% stem	53.33 (46.67)	30.00 (68.96)	46.66 (53.34)
1% stem	26.66 (73.34)	20.00 (79.30)	23.33 (76.67)
5% stem	6.66 (93.34)	0.00 (100)	10.00 (90.00)
0.1% pneumatophore	43.33 (56.67)	53.33 (44.82)	56.66 (43.34)
1% pneumatophore	33.33 (66.67)	36.66 (62.07)	23.33 (76.67)
5% pneumatophore	6.66 (93.34)	3.33 (96.55)	10.00 (90.00)
LSD0.05=	30.52	26.86	21.44
Rhizophora mucronata			
Control	100.00	96.66	100.00
0.1% leaves	93.33 (6.67)	76.66 (20.69)	80.00 (20.00)
1% leaves	40.00 (60.00)	13.33 (86.20)	20.00 (80.00)
5% leaves	6.66 (93.34)	0.00 (100.00)	0.00 (100.00)
0.1% stem	96.66 (3.34)	66.66(31.03)	86.66 (13.34)
1% stem	40.00 (60.00)	13.33 (86.20)	23.33 (76.67)
5% stem	3.33 (96.67)	0.00 (100.00)	6.66 (93.34)
LSD0.05=	20.23	17.21	15.20

Parenthesis shows reduction % as compared to control.

Fifteen days after potato emergence, the soil in each pot was inoculated with 2000 juveniles of *M. javanica.* The juveniles were less than one week old and were obtained from infected brinjal (*Solanum melongena* L.) roots. Soil without mangrove plant parts served as the control. There were three replicates of each treatment and pots were kept randomized in a screen house of the Department of Botany, University of Karachi. The experiment was terminated 65 days after nematode addition, and plant growth parameters in terms of shoot length, shoot weight, root length, root weight were recorded. Infection on roots by root knot nematodes was recorded.

Data were subjected to analysis of variance (ANOVA) followed by the least significant difference (LSD) test and Duncan's multiple range test according to G o m e z and G o m e z (1984).

RESULTS

Root rot fungi: In potato a maximum increase in germination of seeds was observed where *A. marina* leaves and stem powder was used at a 5% concentration (100%) (Tab. 1). The growth parameters like shoot length, root length, shoot weight and root weight showed that the highest increase in length of shoot (60.88%)

Table 3
Effect of mangroves amendments to soil on root knot of potato.

Avicennia marina						
Treatments	**Germination %**	**Shoot length (cm)**	**Shoot weight (g)**	**Root length (cm)**	**Root weight (g)**	**Number of knots**
Control	83.33	18.16	2.48	19.58	1.41	64
0.1% leaves	66.66 (20.00)	27.50 (51.43)	5.64 (127.41)	18.83 (3.83)	1.05 (25.53)	32 (50.00)
1% leaves	83.33 (0.00)	27.66 (52.31)	6.34 (155.6)	20.08 (2.55)	1.24 (12.05)	10 (84.37)
5% leaves	100.00 (20.00)	28.96 (59.47)	7.14 (187.90)	25.00 (27.6)	2.33 (65.24)	0.0 (100.00)
0.1% stem	83.33 (0.00)	22.66 (24.77)	5.51 (122.17)	24.00 (22.57)	2.99 (112.0)	10 (84.37)
1% stem	83.33 (0.00)	22.75 (25.27)	5.92 (138.70)	25.16 (28.49)	3.01 (113.47)	2.0 (96.87)
5% stem	100.00 (20.00)	23.66 (30.28)	6.17 (148.79)	25.66 (31.05)	3.35 (137.58)	1.0 (98.43)
0.1% pneumatophore	50.00 (39.99)	18.85 (3.79)	3.58 (44.35)	19.88 (1.53)	1.63 (15.60)	20 (68.75)
1% pneumatophore	100.00 (20.00)	19.76 (8.81)	3.88 (56.45)	20.95 (6.99)	3.05 (116.3)	2.0 (96.87)
5% pneumatophore	100.00 (20.00)	24.53 (35.07)	5.38 (116.9)	22.96 (17.26)	3.39 (140.42)	0.0 (100.00)
LSD0.05=	35.78	21.24	4.74	16.76	1.88	10.98
Rhizophora mucronata						
Control	66.66	9.99	2.51	10.18	0.24	48
0.1% leaves	83.33 (25.00)	12.46 (24.72)	3.24 (29.08)	10.82 (6.28)	0.33 (37.5)	30 (37.5)
1% leaves	100 (50.00)	13.0 (30.13)	4.28 (70.51)	11.42 (12.18)	0.37 (54.16)	2.0 (95.83)
5% leaves	100 (50.00)	14.54 (45.54)	4.74 (88.84)	12.32 (21.02)	0.47 (95.83)	1.0 (97.91)
0.1% stem	83.33 (25.00)	10.48 (4.90)	3.05 (21.51)	10.74 (5.50)	0.26 (8.33)	24 (50.00)
1% stem	100 (50.00)	11.70 (17.11)	4.15 (65.33)	11.59 (13.85)	0.39 (62.5)	7.0 (85.41)
5% stem	100 (50.00)	13.76 (37.73)	4.35 (73.30)	11.76 (15.52)	0.42 (75.00)	0.0 (100)
LSD0.05=	35.43	1.85	1.31	1.76	0.12	5.33

Parenthesis shows reduction % in number of knots and increase % in growth parameters as compared to control.

(71.07%) and root (25.71%) (4.95%) was observed at 1 and 5% concentrations of stem and pneumatophore powder of *A. marina.* A maximum increase in root (60.3%) (17.46%) and shoot weight (84.89%) (38.92%) was observed at 1 and 5 % concentrations of stem and pneumatophore powder. There was an increase (26.19%) (37.41%) in shoot length and shoot weight (72.68%) (86.59%) of *R. mucronata* leaves and stem powder used at 5% concentration. There is a maximum increase in germination, shoot weight and root weight which is used at 5% concentration as compared to the control (Tab. 1). *A. marina* showed the longer shoot and root length as compared to *R. mucronata* plant parts.

Infection by root rot fungi was reduced when *A. marina* and *R. mucronata* plants powder was applied at 5% concentration. *A. marina* stem powder used at 5% concentration showed complete suppression (100%) of *R. solani.* Similarly, the infection by *M. phaseolina* and *R. solani* was completely suppressed (100%) when *R. mucronata* plant parts were used at 5% concentration. Leaves powder of *R. mucronata* was the most effective in the control of root infecting fungi, whereas stem powder of *A. marina* was the most effective (Table 2).

Root knot nematode: Soil amendment with *A. marina* leaves, stem and pneumatophore at 1 and 5% concentrations reduced the root knot development on potato followed by *R. mucronata* as compared to the control (Tab. 3). Soil amendment at 1 and 5% concentrations also increased the plant height, weight and root weight of *R. mucronata*. The plant showed maximum germination when *A. marina* (20.00%) and *R. mucronata* (50.00%) plant parts were used at 1 and 5% concentrations. Complete suppression of root knot (100%) was observed when *A. marina* leaves and pneumatophore were used at 5% concentration, whereas *R. mucronata* stem powder showed complete suppression of root knot at 5% concentration. Of the different mangrove plant parts used, leaves showed better results on the growth of the plant, whereas the stem and pneumatophore of *A. marina* showed better results in suppression of the number of root knots (Tab. 3). *R. mucronata* leaves powder significantly increased the growth parameters while stem powder showed maximum inhibition of root knots (Tab. 3).

DISCUSSION

The addition of organic materials to soil infested with plant pathogens has been clearly demonstrated as a satisfactory control method, particularly against root knot nematodes (Ehteshamul-Haque et al. 1995). The present study describes the effect of soil amendment with different plant parts of *A. marina* and *R. mucronata* in the control of root infecting fungi and root knot nematodes on potato. There are reports where soil amendments with oil cakes like cotton cake and neem cake showed significant results in the control of root infecting fungi: *F. solani*, *M. phaseolina* and *R. solani* (Ehteshamul-Haque et al. 1995). Similarly, the use of seaweeds *Stoechospermum marginatum*, neem cake and cotton cake (Ehteshamul-Haque et al. 1998) showed promising results in the control of root infecting fungi on sunflower. Germination of potato seeds, shoot length, root length, shoot weight and root weight were increased where *A. marina* and *R. mucronata* plant parts were used at 1 and 5% concentrations. A similar result was observed by Dawar et al. (2007) on mung bean and chick pea with *Eucalyptus* sp. The present result showed that infection by *Fusarium* spp., *R. solani* and *M. phaseolina* was reduced on potato when mangrove plant parts were used at 5% concentration. Similarly, Mehdi et al. (2000) showed that *R. mucronata* used alone or in combination with *Paecilomyces lilacinus* significantly suppressed root infecting fungi. Complete suppression of *R. solani* was observed on potato when *A. marina* and *R. mucronata* were used at 5% concentration.

In the present study germination of potato tubers, plant weight, height, root length and shoot length increased when *A. marina* parts and *R. mucronata* plant parts were used at 1 and 5% concentrations. Tariq et al. (2007) observed that germination and plant growth parameters were significantly increased in mash bean and okra plants when leaves and stem powder of *R. mucronata* were used at 5% concentration. The present result showed that *A. marina* and *R. mucronata* stem powder were more effective as compared to leaves and pneumatophore powder in suppression of root knot, whereas Mehdi et al. (2001) reported that *A. marina* and *R. mucronata* with or without *Pseudomonas aeruginosa* significantly reduced the root knot infection in tomato. Similarly, the application of *P. lilacinus* on brinjal and mung bean (Zaki and Maqbool, 1992) on groundnut (Patel et al. 1995) significantly controlled plant parasitic nematodes.

CONCLUSION

Use of organic amendments is a very promising method in the control of diseases in Pakistan for potato and other valuable crops. However, further research is required in order to enhance the impact of such amendments on pathogens.

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Wpływ dodatków do gleby z roślin namorzynowych na zgniliznę korzeni i narośla na korzeniach ziemniaka (*Solanum tuberosum* L.).

Streszczenie

Liście, łodygi i pneumatofory *Avicennia marina* oraz liście i łodygi *Rhizophora mucronata* zastosowano jako organiczne dodatki do gleby w stężeniu 0,1, 1 i 5% do zwalczania grzybów powodujących zgniliznę korzeni, takich jak *Fusarium* spp., *Rhizoctonia solani* i *Macrophomina phasoelina*, oraz nicieni *Meloidogyne javanica* powodujących narośla na korzeniach ziemniaka. W doświadczeniach wazonowych kiełkowanie nasion, masa pędu, długość korzenia, masa korzenia znacznie zwiększyły się, a liczba narośli zmniejszyła się, kiedy części roślin *A. marina* i *R. mucronata*, takie jak liście, łodygi i pneumatofory, stosowano w stężeniu 1 i 5%. Nastąpiło zupełne zablokowanie zakażenia przez *R. solani* i *M. phaseolina*, kiedy części roślin *A. marina* i *R. mucronata* stosowano w stężeniu 5% w uprawach ziemniaka. Maksymalne zahamowanie narośli wywoływanych przez *M. javanica* obserwowano, kiedy proszek zrobiony z części roślin namorzynowych stosowano w stężeniu 1 i 5%. Proszek ze wszystkich części roślin, takich jak liście, łodygi i pneumatofory, był skuteczny w blokowaniu działania grzybów porażających korzenie i nicieni *Meloidogyne javanica*.