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EFFICACY OF *PSEUDOMONAS AERUGINOSA* AND *PAECILOMYCES LILACINUS* IN THE CONTROL OF ROOT ROT-ROOT KNOT DISEASE COMPLEX ON SOME VEGETABLES

by

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Summary. *Pseudomonas aeruginosa* and *Paecilomyces lilacinus* used alone or together significantly ($P < 0.05$) reduced infection of *Meloidogyne javanica* root knot nematode and root infecting fungi viz., *Macrophomina phaseolina*, *Rhizoctonia solani*, *Fusarium solani* and *F. oxysporum* on pumpkin (*Cucurbita pepo*), guar (*Cyamopsis tetragonoloba*), chilli (*Capsicum annuum*) and watermelon (*Citrullus lanatus*). *P. aeruginosa* was more effective than *P. lilacinus* in reducing the *M. javanica* root knot nematode infection. Combined use of *P. lilacinus* and *P. aeruginosa* was more effective in reducing the infection of root knot nematode in guar, *M. phaseolina* and *F. oxysporum* on pumpkin and *F. solani* on guar and watermelon than either used alone.

The association of root knot nematode *Meloidogyne* spp., with root infecting fungi produces greater losses than either pathogen alone (Starr *et al.*, 1989). Many vegetable crops like pumpkin, guar, chilli and watermelon were found infected with both root knot nematode and root infecting fungi in Pakistan (Ghaffar, 1995). Of the microbial antagonists, the bacteria belonging to the fluorescent *Pseudomonas* eg., *Pseudomonas fluorescens* and *P. putida* which colonize roots of a wide range of crop plants, are reported to be antagonistic to soilborne plant pathogens like *Rhizoctonia solani*, *Pythium ultimum*, *P. debaryanum* and *P. aphanidermatum* (Suslow and Schorth, 1982). Previous studies showed that the plant growth promoting rhizobacterium *P. aeruginosa* inhibited the infection of root infecting fungi on chickpea (Izhar *et al.*, 1995). In the present study *P. aeruginosa* (Schroeter) Migula was used with or without *Paecilomyces lilacinus* (Thom) Samson

in the control of root disease complex of vegetables caused by *Meloidogyne javanica* (Treub) Chitw. and root infecting fungi viz., *Macrophomina phaseolina* (Tassi) Goid, *Rhizoctonia solani* Kuehn and *Fusarium* spp.

Materials and methods

Seeds of pumpkin (*Cucurbita pepo* L.), watermelon [*Citrullus lanatus* (Thunb.) Matsum. *et* Nakai], guar [*Cyamopsis tetragonoloba* (L.) Taub.] and chilli (*Capsicum annuum* L.), five per pot, were sown in 8 cm diam. plastic pots containing 250 g sandy loam soil, pH 8.05. The pots were drenched with 25 ml conidial or cell suspension of *P. lilacinus* 10^7 cfu ml⁻¹ and or *P. aeruginosa* 10^8 cfu ml⁻¹. The soil had a natural infestation of 3-10 sclerotia of *M. phaseolina* g⁻¹ of soil as found by a wet sieving and dilution technique (Sheikh and Ghaffar, 1975), 7.5% col-

TABLE I - Effect of *Pseudomonas aeruginosa* and *Paecilomyces lilacinus* in the control of root disease complex in some vegetables.

Treatment	Root Knot Index	INFECTION %			
		<i>M. phaseolina</i>	<i>R. solani</i>	<i>F. solani</i>	<i>F. oxysporum</i>
PUMPKIN					
Control	3.1	87	25	56	75
<i>P. lilacinus</i> (PL)	1.2	94	0	44	62
<i>P. aeruginosa</i> (PA)	0.6	50	6	19	44
PL + PA	0.5	19	0	19	6
GUAR					
Control	4.1	31	0	75	81
<i>P. lilacinus</i> (PL)	3.5	6	0	62	81
<i>P. aeruginosa</i> (PA)	2.0	19	0	44	50
PL + PA	1.4	6	0	37	44
CHILLI					
Control	3.3	31	19	75	37
<i>P. lilacinus</i> (PL)	2.9	19	0	56	44
<i>P. aeruginosa</i> (PA)	2.5	12	6	75	12
PL + PA	2.1	12	25	69	12
WATERMELON					
Control	3.8	62	44	69	12
<i>P. lilacinus</i> (PL)	2.8	69	12	81	0
<i>P. aeruginosa</i> (PA)	1.5	25	12	69	0
PL + PA	1.5	37	0	44	0
L.S.D. (P=0.05)	0.34	6.1	6.1	6.1	6.1

onization of *R. solani* on sorghum seeds used as baits (Wilhelm, 1955) and 3500 cfu g⁻¹ of soil of a mixed population of *F. oxysporum* Schlecht. emend. Snyder et Hans and *F. solani* (Mart) Appel et Wollenw. emend. Snyder et Hans as assessed by soil dilution technique (Nash and Snyder, 1962). There were four replicates of each treatment. The pots were randomized on a screen house bench at the M.A.H. Qadri Biological Research Centre, University of Karachi and kept at 50% WHC (Keen and Raczkowski, 1921). After seed germination ten egg masses of *M. javanica* of equal size obtained from brinjal

(*Solanum melongena* L.) plants were deposited near the roots of seedlings in each pot.

Plants were uprooted after six weeks growth and after washing in running tap water, the root knot. Index was recorded on a 0-5 scale (Taylor and Sasser, 1978). To assess the incidence of root infecting fungi, five one cm long root pieces from each plant were cut, surface sterilized with 1% Ca(OCl)₂ for three minutes and transferred onto PDA plates containing penicillin (100,000 units/litre) and streptomycin (0.2 g/litre). After incubation for five days at 28 °C the incidence of root infecting fungi viz., *M. phaseolina*, *R. solani*

and *Fusarium* spp., was recorded. Data were analysed and subjected to Factorial ANOVA (FANOVA) followed by least significant differences (LSD) according to Gomez and Gomez (1984).

Results and Discussion

P. lilacinus and *P. aeruginosa* used alone or together significantly ($P < 0.05$) reduced gall formation in pumpkin, guar, chilli and watermelon. *P. aeruginosa* was more effective than *P. lilacinus* in reducing the infection of root knot nematode. Combined use of *P. lilacinus* and *P. aeruginosa* was more effective on guar and chilli than their individual use (Table I).

Infection of *M. phaseolina* and *F. oxysporum* was significantly ($P < 0.05$) reduced on pumpkin,

guar, chilli and watermelon when *P. aeruginosa* was used alone or mixed with *P. lilacinus*. *P. lilacinus* was effective against *M. phaseolina* infection on guar and chilli and *F. oxysporum* infection on pumpkin and watermelon. Infection of *R. solani* was significantly ($P < 0.05$) reduced by *P. lilacinus* and *P. aeruginosa* on pumpkin, chilli and watermelon while on guar, infection of *R. solani* was not observed. *F. solani* infection was also significantly ($P < 0.05$) reduced by *P. lilacinus* and *P. aeruginosa* on pumpkin, guar and chilli, while on watermelon their combined use was effective (Table I). Use of *P. aeruginosa* and *P. lilacinus* significantly ($P < 0.05$) increased plant height of pumpkin, guar, chilli and watermelon and fresh weight of shoot on pumpkin and watermelon (Table II).

Use of plant growth promoting bacterium *P.*

TABLE II - Effect of *P. aeruginosa* and *P. lilacinus* on growth of some vegetables.

Treatment	Germination %	Fresh weight of shoot (g)	Plant height (cm)
PUMPKIN			
Control	40	4.2	26.5
<i>P. lilacinus</i> (PL)	50	6.7	32.2
<i>P. aeruginosa</i> (PA)	55	7.2	30.0
PL + PA	50	5.9	28.2
GUAR			
Control	65	3.7	24.5
<i>P. lilacinus</i> (PL)	80	4.1	28.0
<i>P. aeruginosa</i> (PA)	75	3.9	27.7
PL + PA	75	3.9	32.0
CHILLI			
Control	65	0.52	10.5
<i>P. lilacinus</i> (PL)	60	0.76	14.5
<i>P. aeruginosa</i> (PA)	70	0.9	16.5
PL + PA	60	0.97	14.7
WATERMELON			
Control	60	2.5	35.1
<i>P. lilacinus</i> (PL)	70	3.0	37.5
<i>P. aeruginosa</i> (PA)	80	3.7	35.0
PL + PA	75	3.2	38.5
L.S.D. ($P=0.05$)	11.1	0.55	2.2

aeruginosa was more effective than *P. lilacinus* in reducing the root disease of vegetables like pumpkin, guar, chilli and watermelon. This could presumably be due to the fact that *P. lilacinus* parasitizes only the eggs of *Meloidogyne* (Jatala, 1986) by destroying the chitinous egg shell. In contrast fluorescent *Pseudomonas*, the plant growth promoting rhizo-bacteria, produce iron chelating siderophores (Kloepper *et al.*, 1980; Leong, 1986), antibiotics or hydrogen cyanide (Ahl *et al.*, 1986) and these compounds have been implicated in reduction of pathogenic rhizospheric microorganisms, creating an environment favourable for root growth (Kloepper *et al.*, 1980; Leong, 1986). Siderophore activity, antibiotic production, plant hormone production, toxin development and induced resistance are the mechanisms reported against pathogenic fungi (Weller, 1988), whereas against nematodes these rhizobacteria reduced the hatching and also invasion by the production of toxic metabolites (Spiegel *et al.*, 1991), nematicidal components (Becker *et al.*, 1988) and alteration of specific root exudates which control nematode behavior (Oostendorp and Sikora, 1990; Racke and Sikora, 1992).

Acknowledgements. The work was carried out under a research grant of Pakistan Atomic Energy Commission, Islamabad, which is sincerely acknowledged.

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