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Screening of Rhizo-Bacterial Isolates for Bio-control Potential against Soil-Borne Diseases in Brinjal

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Studies were carried out from 2013 to 2015 with the objectives to isolate and identify some indigenous rhizobacterial strains against major soil-borne pathogens of brinjal. Seventy thizobacterial isolates were characterized based on colony characters, morphological and biochemical test and identified as *Pseudomonas flourescens* (30), *P. aeruginosa* (13), *P. aureofaciens* (2) and *Bacillus subtilis* (25). *In vitro* bioassay of the seventy rhizobacterial isolates revealed that the isolate I-58 was the most effective rhizobacterial isolate, followed by I-30 and I-55 isolates in inhibiting the radial growth of test pathogens.

Kewords: Brinjal, soil-borne diseases, rhizobacteria, biochemical characterization.

Brinjal or eggplant (*Solanum melongena* L.), of the family Solanaceae is quite popular as the poor man's crop suffer from various soil-borne disease which emerged as major biotic stress in successful cultivation of this crop in India (Gupta *et al.,* 2013). Soil borne plant pathogens responsible for the diseases due to their persistence nature in soil become more challenging and simultaneous infection by multiple soil-borne plant pathogens results in disease complex that further reduced the yield and quality of the brinjal crop (Koike *et al*., 2003). Currently, the management of soil- borne diseases has been done with the application of chemical fungicides. However, it may not be sustainable in the longer run as chemical fungicides are known to cause residual toxicity, toxicity to non-target organisms and other environmental hazards. In recent times much emphasis is being given to manage the soil borne diseases of the crop by employing the plant growth promoting rhizobacteria (Compant *et al.,* 2005). The mechanisms of PGPR included regulating hormonal and nutritional balance, inducing resistance against plant pathogens and solubilizing nutrients for easy uptake by plants (Vejan *et al*., 2016). The use of PGPR inoculants as biofertilizers is due to the production of some plant growth promoting substances, production of enzymes and production of some antifungal and antibacterial secondary metabolites (Weller, 1988) and as antagonists of phytopathogens due to secretion of antibiotics provide a promising alternative to chemical fertilizers and pesticides (Apastambh *et al*. 2016; Glick, 2012). The objectives of this study is to isolates the plant growth promoting bacteria from the rhizosphere of brinjal crop, their bio-chemical characterization and bio-control potential against major soil - borne plant pathogens of brinjal crop.

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MATERIALS AND METHODS

Isolation of rhizobacterial isolates

Soil samples were collected from the rhizosphere of healthy brinjal plants was processed for isolation of rhizobacterial isolates by serial dilution method (Dhingra and Sinclair, 1995).

Table 1. Cultural and morphological characteristics of rhizobacterial isolates

Isolate	Colony characteristics			Microscopic characteristics	
	Colour	Shape	Nature	Cell shape	Gram reaction
I-1	White	Round	Non-spreading	Long rods	Gram +ve
I-2	Cream	Round	Non-spreading	Long rods	Gram +ve
I-3	Green	Irregular	Spreading	Short rods	Gram -ve
I-4	Light green	Irregular	Spreading	Long rods	Gram-ve
I-5	Green	Irregular	Spreading	Short rods	Gram -ve
I-6	Light green	Irregular	Spreading	Short rods	Gram -ve
I-7	White	Round	Non-spreading	Long rods	Gram +ve
I-8	Green	Irregular	Spreading	Long rods	Gram -ve
I-9	Light green	Irregular	Spreading	Short rods	Gram -ve
I-10	Green	Irregular	Spreading	Long rods	Gram -ve
I-11	Light green	Irregular	Spreading	Short rods	Gram -ve
I-12	White	Round	Non-spreading	Short rods	Gram +ve
I-13	Cream	Round	Non-spreading	Long rods	Gram +ve
I-14	Cream	Round	Non-spreading	Long rods	Gram +ve
I-15	Green	Irregular	Spreading	Short rods	Gram -ve
I-16	Light green	Irregular	Spreading	Long rods	Gram -ve
I-17	Green	Irregular	Spreading	Long rods	Gram -ve
I-18	White	Round	Non-spreading	Long rods	Gram +ve
I-19	White	Round	Non-spreading	Short rods	Gram +ve
I-20	Green	Irregular	Spreading	Long rods	Gram -ve
I-21	Green	Irregular	Spreading	Long rods	Gram -ve
I-22	Green	Irregular	Spreading	Short rods	Gram -ve
I-23	White	Round	Non-spreading	Short rods	Gram +ve
I-24	White	Round	Non-spreading	Long rods	Gram +ve
I-25	Light green	Irregular	Spreading	Short rods	Gram -ve
I-26	Light green	Irregular	Spreading	Short rods	Gram -ve
I-27	Green	Irregular	Spreading	Long rods	Gram -ve
I-28	Light green	Irregular	Spreading	Long rods	Gram -ve
I-29	White	Round	Non-spreading	Short rods	Gram +ve
I-30	Light green	Irregular	Spreading	Long rods	Gram -ve
I-31	Green	Irregular	Spreading	Short rods	Gram -ve
I-32	Light green	Irregular	Spreading	Short rods	Gram -ve
I-33	Cream	Round	Non-spreading	Long rods	Gram +ve
I-34	White	Round	Non-spreading	Long rods	Gram +ve
I-35	Green	Irregular	Spreading	Short rods	Gram -ve
I-36	Light green	Irregular	Spreading	Long rods	Gram -ve
I-37	Light green	Irregular	Spreading	Long rods	Gram -ve
I-38	Green	Irregular	Spreading	Long rods	Gram -ve
I-39	Light green	Irregular	Spreading	Short rods	Gram -ve
I-40	White	Round	Non-spreading	Long rods	Gram +ve
I-41	Green	Irregular	Spreading	Long rods	Gram -ve
I-42	Light green	Irregular	Spreading	Short rods	Gram -ve
I-43	Light green	Irregular	Spreading	Short rods	Gram -ve
I-44	White	Round	Non-spreading	Long rods	Gram +ve
I-45	White	Round	Non-spreading	Short rods	Gram +ve
I-46	Cream	Round	Non-spreading	Short rods	Gram +ve
I-47	Green	Irregular	Spreading	Long rods	Gram -ve
I-48	Green	Irregular	Spreading	Long rods	Gram -ve
I-49	Light green	Irregular	Spreading	Short rods	Gram -ve
I-50	Light green	Irregular	Spreading	Long rods	Gram -ve

I-51	White	Round	Non-spreading	Short rods	Gram +ve
I-52	Cream	Round	Non-spreading	Short rods	Gram +ve
I-53	Green	Irregular	Spreading	Long rods	Gram -ve
I-54	Green	Irregular	Spreading	Long rods	Gram -ve
I-55	Light green	Irregular	Spreading	Short rods	Gram -ve
I-56	White	Round	Non-spreading	Long rods	Gram +ve
I-57	White	Round	Non-spreading	Long rods	Gram +ve
I-58	Green	Irregular	Spreading	Long rods	Gram -ve
I-59	Green	Irregular	Spreading	Short rods	Gram -ve
I-60	Light green	Irregular	Spreading	Short rods	Gram -ve
I-61	Light green	Irregular	Spreading	Long rods	Gram –ve
I-62	Green	Irregular	Spreading	Long rods	Gram –ve
I-63	Light green	Irregular	Spreading	Short rods	Gram +ve
I-64	Green	Irregular	Spreading	Long rods	Gram +ve
I-65	Green	Irregular	Spreading	Long rods	Gram +ve
I-66	Light green	Irregular	Spreading	Long rods	Gram +ve
I-67	Green	Irregular	Spreading	Short rods	Gram +ve
I-68	White	Round	Non-spreading	Long rods	Gram –ve
I-69	White	Round	Non-spreading	Long rods	Gram +ve
I-70	Light green	Irregular	Spreading	Long rods	Gram -ve

Single colonies formed were picked and streaked separately on petriplates containing nutrient agar and King's B media and purified by streak plate method (Koch, 1881).

Identification of isolated rhizobacteria

Isolates of rhizobacteria, isolated from the rhizosphere of healthy brinjal plants were identified based upon their colony characters, microscopic characteristics (Gram, 1884) and biochemical characters *viz*., starch hydrolysis (Iverson and Millis, 1974), catalase test (Schaad, 1992), oxidase test (Gordon and McLeod, 1928), spirit blue Agar, lipid hydrolysis (Cowan, 1974), levan production (Lelliot and Stead, 1987), casein hydrolysis (Kunz and Lonnerdal, 1990), arginine hydrolysis (Lelliot and Stead, 1987), gelatinase (Blazevic and Ederer, 1975), pectinase activity (Fogarty and Kelly, 1983), protease activity (Vieira, 1999) and endospore formation.

***In vitro* evaluation of rhizobacterial isolates against the soil borne pathogens**

The isolated rhizobacterial isolates were tested under *in vitro* conditions, against the major soil borne fungal pathogens *viz*., *Fusarium oxysporum* f. sp. *melongenae, Rhizoctonia solani* and *Sclerotium rolfsii* responsible for causing wilt, collar rot and root rot respectively in brinjal crop by using dual culture technique (Morton and Stroube, 1955). Observation regarding per cent inhibition of mycelial growth of pathogens was calculated (Wong *et al*., 2003)

RESULTS AND DISCUSSION

Isolation and identification rhizobacterial isolates

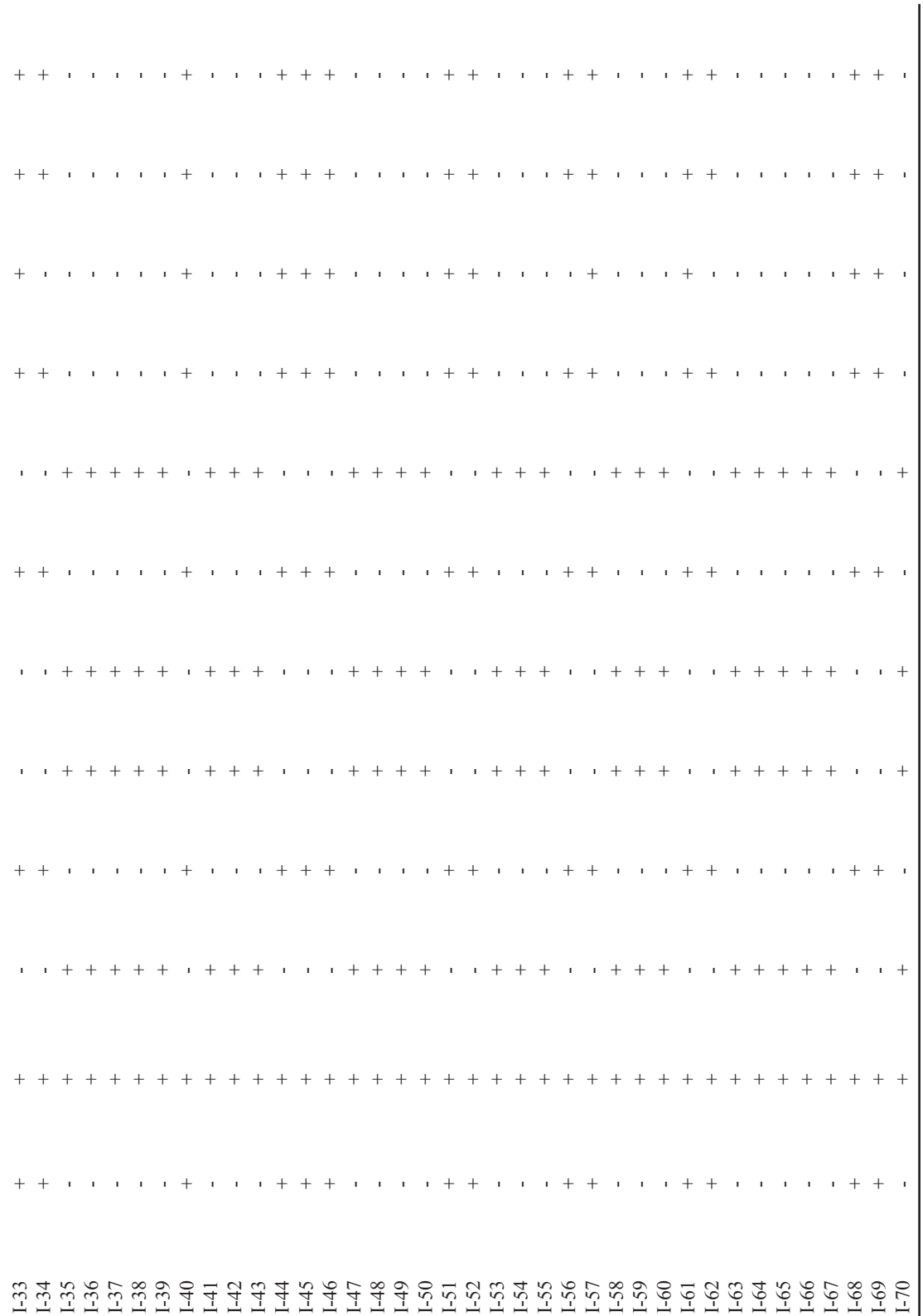
Seventy rhizobacterial isolates were isolated from the brinjal fields across the locations surveyed. The selected rhizobacterial strains were purified by streak plate method and characterized based on colony characters, morphological and biochemical characteristics.The isolated rhizobacterial isolates exhibited variations in their colony characteristics (Table 1). Out of 70 isolates, 23 produced light green, 24 green, 17 white and 6 cream coloured colonies**.** Of these, 25 colonies were round and 45 were irregular in shape. Forty five isolates produced non-spreading type of colonies, whereas, 25 produced colonies that were spreading in nature. Further, microscopic examinations of isolated rhizobacteria revealed that out of the 70 isolates, 41 isolates had long rod shaped cells and the remaining 29 had short rod shaped cells, of which 45 strains showed Gram negative reaction and remaining 25 showed Gram positive reactions.

Biochemical characterization

Data in the table 2 indicated that the isolated rhizobacterial strains were tested for their

Table 2. Biochemical characteristics of rhizobacterial strains

Isolate	Starch Hydrolysis	Catalase	Oxidase	Spirit blue Agar	Lipid hydrolysis	Levan	Casein hydrolysis	Arginine hydrolysis	Gelatinous activity	Pectinase Activity	Protease activity	Endospore formation
I-1	+	+	-	+	-	-	+	-	+	+	+	+
I-2	+	+	-	+	-	-	+	-	+	+	+	+
I-3	-	+	+	-	+	+	-	+	-	-	-	-
I-4	-	+	+	-	+	+	-	+	-	-	-	-
I-5	-	+	+	-	+	+	-	+	-	-	-	-
I-6	-	+	+	-	+	+	-	+	-	-	-	-
I-7	+	+	-	+	-	-	+	-	+	+	+	+
I-8	-	+	+	-	+	+	-	+	-	-	-	-
I-9	-	+	+	-	+	+	-	+	-	-	-	-
I-10	-	+	+	-	+	+	-	+	-	-	-	-
I-11	-	+	+	-	+	+	-	+	-	-	-	-
I-12	+	+	-	+	-	-	+	-	+	-	+	+
I-13	+	+	-	+	-	-	+	-	+	+	+	+
I-14	+	+	-	+	-	-	+	-	+	+	+	+
I-15	-	+	+	-	+	+	-	+	-	-	-	-
I-16	-	+	+	-	+	+	-	+	-	-	-	-
I-17	-	+	+	-	+	+	-	+	-	-	-	-
I-18	+	+	-	+	-	-	+	-	+	+	+	+
I-19	+	+	-	+	-	-	+	-	+	+	+	+
I-20	-	+	+	-	+	+	-	+	-	-	-	-
I-21	-	+	+	-	+	+	-	+	-	-	-	-
I-22	-	+	+	-	+	+	-	+	-	-	-	-
I-23	+	+	-	+	-	-	+	-	+	-	+	+
I-24	+	+	-	+	-	-	+	-	+	+	+	+
I-25	-	+	+	-	+	+	-	+	-	-	-	-
I-26	-	+	+	-	+	+	-	+	-	-	-	-
I-27	-	+	+	-	+	+	-	+	-	-	-	-
I-28	-	+	+	-	+	+	-	+	-	-	-	-
I-29	+	+	-	+	-	-	+	-	+	+	+	+
I-30	-	+	+	-	+	+	-	+	-	-	-	-
I-31	-	+	+	-	+	+	-	+	-	-	-	-
I-32	-	+	+	-	+	+	-	+	-	-	-	-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biochemical characters. In case of starch hydrolysis test, isolate 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 formed a transparent zone around the rhizobacterial colonies that indicated positive test for *Bacillus* spp., whereas, remaining forty five isolates showed negative test, whereas, in case of catalase test, all the 70 rhizobacterial isolates produced gas bubbles when drops of hydrogen peroxide were flooded on them revealing that all the isolates were strict aerobes as well as facultative anaerobes. For oxidase test, the colony colour of 45 isolates viz., 3, 4, 5, 6, 8, 9, 10, 11, 15, 16, 17, 20, 21, 22, 25, 26, 27, 28, 30, 31, 32, 35, 36, 37, 38, 39, 41, 42, 43, 47, 48, 49, 50, 53, 54, 55, 58, 59, 60, 63, 64, 65, 66, 67 and 70 changed to maroon, indicating that the rhizobacterial isolates belonged to the genus *Pseudomonas*, whereas, remaining 25 isolates gave negative result for the test. In case of spirit blue agar test, 25 isolates viz., 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 formed a clear halo around the rhizobacterial colonies that indicated positive test for *Bacillus* spp., whereas, remaining forty five isolates showed negative test. In lipid hydrolysis test, isolate, 3, 4, 5, 6, 8, 9, 10, 11, 15, 16, 17, 20, 21, 22, 25, 26, 27, 28, 30, 31, 32, 35, 36, 37, 38, 39, 41, 42, 43, 47, 48, 49, 50, 53, 54, 55, 58, 59, 60, 63, 64, 65, 66, 67 and 70 formed a transparent zone around the rhizobacterial colonies indicating positive test for *Pseudomonas* spp., remaining 25 isolates gave negative result for the test. In case of levan test, large white, domed, mucoid colonies was formed in forty five isolates viz., 3, 4, 5, 6, 8, 9, 10, 11, 15, 16, 17, 20, 21, 22, 25, 26, 27, 28, 30, 31, 32, 35, 36, 37, 38, 39, 41, 42, 43, 47, 48, 49, 50, 53, 54, 55, 58, 59, 60, 63, 64, 65, 66, 67 and 70 indicating that these rhizobacterial isolates belonged to *Pseudomonas* spp. and remaining twenty five isolates showed negative test. In case of casein hydrolysis, isolate 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 formed a halo zone around the rhizobacterial colonies indicating positive test for *Bacillus* spp., whereas, remaining forty five isolates showed negative test. In arginine hydrolysis, isolate 3, 4, 5, 6, 8, 9, 10, 11, 15, 16, 17, 20, 21, 22, 25, 26, 27, 28, 30, 31, 32, 35, 36, 37, 38, 39, 41, 42, 43, 47, 48, 49, 50, 53, 54, 55, 58, 59, 60, 63, 64, 65, 66, 67 and 70 formed a clear zone around the rhizobacterial colonies indicated positive test for *Pseudomonas* spp. and remaining twenty five isolates showed negative test. In gelatinous test, 25 isolates viz., 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 the liquid medium failed to solidify in gelatin tubes upon refrigeration and a clear halo appeared around the colonies of rhizobacterial isolates indicating positive test for *Bacillus* spp., whereas, remaining forty five isolates showed negative test. For pectinase test, isolate 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 formed a clear halo around rhizobacterial colonies indicating positive for *Bacillus* spp., whereas, the remaining forty five isolates gave negative result against this test. In protease activity, isolate 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 formed a clear zone around the rhizobacterial colonies that indicated positive test for *Bacillus* spp., whereas, remaining forty five isolates showed negative test. In case of endospore formation test isolate 1, 2, 7, 12, 13, 14, 18, 19, 23, 24, 29, 33, 34, 40, 44, 45, 46, 51, 52, 56, 57, 61, 62, 68 and 69 indicated positive test, therefore confirming the rhizobacteria being

Table 3. Identification of the isolated rhizobacterial isolates

Isolate	Identification
I-1, I-2, I-7, I-13, I-14, I-18, I-19, I-23, I-24, I-30, I-33, I-34, I-40, I-45, I-46, I-51, I-52, I-56, I-57, I-61, I-62, I-68 and I-69	*Bacillus subtilis* (25)
I-3, I-4, I-5, I-6, I-9, I-10, I-16, I-17, I-20, I-22, I-25, I-26, I-27, I-31, I-32, I-37, I-38, I-39, I-42, I-43, I-48, I-49, I-50, I-53, I-54, I-58, I-60, I-63, I-67 and I-70	*Pseudomonas fluorescens* (30)
I-8, I-11, I-15, I-21, I-28, I-29, I-35, I-41, I-47, I-55, I-64, I-65 and I-66	*Pseudomonas aeruginosa* (13)
I-36 and I-59	*Pseudomonas aureofaciens* (2)

Table 4. *In vitro* evaluation of rhizobacterial isolates against the soil borne pathogens obtained from brinjal plants

Isolate	Radial growth (mm)			Inhibition over control		
	F	R	S	F	R	S
I-1	34.16	23.33	30.00	62.04	74.07	66.66
I-2	34.00	26.16	25.00	62.22	70.93	72.22
I-3	43.50	36.00	36.00	51.66	60.00	60.00
I-4	34.66	32.66	26.66	61.48	63.71	70.37
I-5	35.00	32.00	30.00	61.11	64.44	66.66
I-6	40.66	45.33	35.33	54.82	49.63	60.74
I-7	20.66	25.33	22.00	77.04	71.85	75.55
I-8	31.50	29.66	26.66	65.00	67.04	70.37
I-9	39.33	40.00	36.33	56.30	55.55	59.63
I-10	38.83	31.50	28.66	56.85	65.00	68.15
I-11	22.33	24.33	21.33	75.18	72.96	76.30
I-12	36.16	35.66	33.33	59.82	60.37	62.96
I-13	36.33	26.66	32.66	59.63	70.37	63.71
I-14	32.16	24.33	28.00	64.26	72.96	68.88
I-15	34.00	24.00	32.16	62.22	73.33	64.26
I-16	31.33	34.66	26.83	65.18	61.48	70.18
I-17	22.83	23.00	20.00	74.63	74.44	77.77
I-18	25.76	24.83	24.00	71.37	72.41	73.33
I-19	25.00	25.00	30.00	72.22	72.22	66.66
I-20	30.33	29.00	30.16	66.30	67.77	66.48
I-21	35.83	33.66	31.66	60.18	62.60	64.82
I-22	24.33	22.66	24.00	72.96	74.82	73.33
I-23	35.33	27.33	34.00	60.74	69.63	62.22
I-24	39.16	35.33	36.50	56.48	60.74	59.44
I-25	39.16	33.66	35.00	56.48	62.60	61.11
I-26	43.50	41.00	41.00	51.66	54.44	54.44
I-27	35.00	29.16	29.00	61.11	67.60	67.77
I-28	34.66	27.33	24.66	61.48	69.63	72.60
I-29	25.16	25.66	24.83	72.04	71.48	72.41
I-30	14.50	16.66	14.66	83.88	81.48	83.71
I-31	23.33	26.33	23.00	74.07	70.74	74.44
I-32	21.33	29.00	18.00	76.30	67.77	80.00
I-33	19.16	27.66	20.66	78.71	69.26	77.04
I-34	42.33	45.00	36.33	52.96	50.00	59.63
I-35	36.83	32.66	35.83	59.07	63.71	60.18
I-36	25.66	22.33	24.66	71.48	75.18	72.60
I-37	26.83	26.33	24.33	70.18	70.74	72.96
I-38	36.00	36.66	27.33	60.00	59.26	69.63
I-39	28.83	32.33	27.50	67.96	64.07	69.44
I-40	32.00	22.66	26.00	64.44	74.82	71.11
I-41	40.66	16.66	34.00	54.82	81.48	62.22
I-42	35.66	27.16	32.00	60.37	69.82	64.44
I-43	15.50	25.33	17.33	83.71	71.85	82.22
I-44	29.50	29.50	31.00	67.22	67.22	65.55
I-45	27.00	24.66	27.00	70.00	72.60	70.00
I-46	33.85	30.00	30.33	62.38	66.66	66.30
I-47	43.00	34.00	40.00	52.22	62.22	55.55
I-48	25.00	24.66	25.33	72.22	72.60	71.85
I-49	46.00	38.00	40.00	48.88	57.77	55.55
I-50	16.00	20.00	16.66	82.22	77.77	80.74

I-51	17.83	22.33	18.33	80.18	75.18	79.63
I-52	28.33	27.66	22.00	68.52	69.26	75.55
I-53	30.33	29.33	29.00	66.30	67.41	67.77
I-54	24.00	25.66	24.66	73.33	71.48	72.60
I-55	15.00	17.00	15.66	83.33	81.11	82.60
I-56	29.33	28.33	32.66	67.41	68.52	63.71
I-57	32.16	30.66	31.66	64.26	65.93	64.82
I-58	13.06	15.33	14.00	85.48	82.96	84.44
I-59	21.33	24.66	22.00	76.30	72.60	75.55
I-60	21.76	24.00	22.00	75.82	73.33	75.55
I-61	21.40	24.00	21.33	76.22	73.33	76.30
I-62	34.66	30.00	33.33	61.48	66.66	62.96
I-63	30.66	35.00	31.66	65.93	61.11	64.82
I-64	34.00	28.00	31.33	62.22	68.88	65.18
I-65	39.16	33.66	31.00	56.48	62.60	65.55
I-66	30.83	26.33	25.00	65.74	70.74	72.22
I-67	15.80	19.66	16.00	82.77	78.15	81.48
I-68	25.83	26.00	24.00	71.30	71.11	73.33
I-69	26.00	27.00	25.00	71.11	70.00	72.22
I-70	17.00	24.00	16.33	81.11	73.33	81.85
Control	90.00	90.00	90.00	0.00	0.00	0.00
S.Em(±)	2.37	1.35	1.54			
CD (P=0.05)	6.64	3.73	4.32			

Bacillus spp., as by adopting differential staining technique the endospores retained the primary dye i.e., malachite green, whereas, the vegetative cells lost the stain. Based on the studies regarding the morphological, biochemical and physiological characteristics and the capability of the isolates to grow at different temperatures, 30 isolates were identified as *Pseudomonas flourescens*, 13 were identified as *P. aeruginosa,* 2 as *P. aureofaciens* and 25 as *Bacillus subtilis* (Table 3). Our results are in confirmatory with the findings of earlier workers who also characterize the rhizobacteria on the basis of phenotypic and bio-chemical test (Rhodes, 1959; Palleroni, 1975; Fritze, 2002). Bacillus and Pseudomonas are the most frequently reported genera of PGPR (Zahid *et al.,* 2015)

Evaluation of rhizobacterial isolates against the test pathogens

A perusal of the data presented in Table 4 revealed out of the 70 rhizobacterial isolates, the efficacy of *Pseudomonas flourescens* isolate I-58, *Bacillus subtilis* isolate I-30 and *Pseudomonas fluorescens* isolate I-55, was superior to other isolates with regard to inhibiting the growth of the test pathogens. The rhizobacterial isolate I-58 (*P. flourescens*) shown significant reduction in the radial growth of the test pathogens i.e., *F. oxysporum* f. sp. *melongenae*, *R. solani* and *S. rofsii.* In case of *F. oxysporum* f. sp. *melongenae* the minimum radial growth of 13.06 mm was recorded thereby effecting 85.48 per cent reduction in radial growth over control. In case of *R. solani* the isolate I-58 effected 82.90 per cent reduction over control (15.33 mm radial growth). With the isolate I-58 minimum radial growth of 14.00 mm with 84.44 per cent inhibition over control was recorded against *S. rofsii.* The rhizobacterial isolate I-58 was statistically at par with *P. flourescens* isolates I-55, I-43, I-50, I-67 and I-70 and *Bacillus subtilis* isolates I-30, I-33 and I-51. As per the effectivity of the rhizobacterial isolates, I-58 was followed by isolate I-30. influenced radial growth of 14.50 mm resulting in growth inhibition of 83.88 per cent over control in case of *F. oxysporum* f. sp. *melongenae*, 16.66 mm growth with 81.48 per cent growth inhibition over control in case of *R. solani* and 14.66 mm growth with 83.71 per cent reduction in growth over control in case of *S. rofsii.* The isolate I-30 was found to be at par with *P. flourescens* isolates I-55 and I-67 and *Pseudomonas aeruginosa* isolate I-41. The data further exhibited that isolate I-55 resulted in the radial growth of 15.00 mm with 83.33 per cent reduction in growth over control in case of *F. oxysporum* f.

sp. *melongenae*. It also resulted in radial growth of 15.66 mm with 82.60 per cent reduction in growth over control in case of *R. solani*. Isolate I-55 caused 81.11 per cent inhibition of mycelial growth of *S. rofsii* (17.00 mm radial growth). However, I-55 was at par with the *P. flourescens* isolates I-32 and I-70. Tennakoon (2007) reported the inhibition of the mycelial growth of one or the other pathogens (*Pestolotia thea, Fusarium oxysporum* f. sp. *carthami* and *Rhizoctonia bataticola*) by volatile metabolites produced by 7 out of 11 isolates of fluorescent pseudomonads and two out of three *Bacillus* isolates. Biswas and Singh (2008) used *Bacillus subtilis*, *P. fluorescens* and *T. viridae* against wilt of tomato and observed that *P. fluorescens* was effective in minimizing the disease. *B. subtilis* inhibited the growth of *F. oxysporum* and and recommended to purify antifungal compounds (Khan *et al*., 2011). As reported by Nandakumar *et al.* (2001) and Asha *et al.* (2011) inhibition of mycelial growth of *R. solani* was due to nutritional competition, colonization of fungal hyphae production of inhibitory compounds by the rhizobacteria.

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