

17 ABSTRACT

Discharge of textile industrial effluent without proper treatment has become a severe hazard for the animal health and environment worldwide. Therefore, this study was designed to isolate azo dye-degrading bacteria from textile wastewater and evaluate their ability to biodegrade reactive dyes into non-toxic products. The potent bacterial strain which was isolated from textile wastewater was identified as *Pseudomonas monteilii* strain RZT1 on the basis of 16S rDNA sequence. The isolated bacterial strain exhibited good decolorization ability with yeast extract supplementation as cosubstrate in static conditions for Malachite Green dye. The optimal condition for the decolorization of Malachite Green dye by *P. monteilii* strain RZT1 were at pH 7.0 and 35°C. Decolorization rates of Malachite Green dye by *P. monteilii* strain RZT1 were varied with initial dye concentration as follow: 84.8%, 75.4%, 63.4% and 45.5% decolorization for 100ppm, 200ppm, 300ppm and 400ppm initial dye concentration respectively. We investigated the effects of dyes used in the textile industry on the seed germination of Five crops - Rice (*Oryza sativa*), Wheat (*Triticum aestivum* L.), Khesari (*Lathyrus sativus*), Mustard (*Brassica Nigra*) and Bitter Melon (*Momordica charantia*). It was found that textile dye Malachite Green had negative effect on seed germination and seedling growth in test cultures. The harmful effects of dye on seed germination and early seedling growth parameters were augmented with increase of dye concentration. Interestingly, treatment of the Malachite Green dye with isolated bacteria reduced the adverse effects of that dye on seed germination and seedling growth. Thus, it indicated the potentiality of *P. monteilii* strain RZT1 for bioremediation of textile effluents into a non-toxic form for plants.

18
19 **Keywords:** Decolourization, Detoxification, Azo dye, *Pseudomonas monteilii* strain RZT1, Seed
20 germination

21 22 1. INTRODUCTION

23 "Environmental pollution due to the release of industrial wastewater containing many types of
24 azo dyes is a big problem worldwide. Azo dyes are used in many industries such as textiles
25 dyestuffs, foodstuffs, cosmetics and printing. Recently, the deterioration of water resources with
26 the rapid growth of industries (sugar, paper, tannery, textile and dyeing industries) in many
27 countries has come into the discussion. It generally disrupts the habitats of the living organisms
28 when discharged into the environment without proper treatment" [1]. "The continuous irrigation
29 of agricultural land with the effluent wastewater causes heavy metal accumulation in the grown
30 crops" [2]. "When this effluent discharged into the watercourses, they restrict the light
31 penetration and inhibit the activities of aquatic lives by decreasing photosynthesis and
32 oxygenation of water reservoirs" [3]. Moreover, the many Azo dyes are reported as xenobiotic,
33 mutagenic and carcinogenic [4-7]. Therefore, wastewater contaminated with azo dyes appears
34 as serious problems due to their negative impacts on water ecosystems and human health.

35 Effects of wastewater from the textile industry on plants have been studied by some workers [8-
36 10]. However, the harmful effects of textiles wastewater from plants depends on the species, the
37 stage of the plant's life cycle is affected by, and the types and concentrations of harmful
38 substances in the effluent. Over the past three decades, some physical, chemical and biological
39 bleaching methods have been adopted by the paper and textile industries [11-14]. Various
40 physical methods can used to remove Azo dyes of wastewater. Some of these methods are
41 effective but quite expensive because they create a significant amount of chemicals. In such
42 situations, bioremediation can be a real hope. Various types' microorganisms including bacteria,

43 fungi, yeasts, actinomycetes and algae capable of breaking down azo dyes have also been
44 used for biodegradation of textile dyes [11, 15-22]. So, the present study was designed for
45 isolation of potent bacterial strain from local textile wastewater which was able to decolorize as
46 well as detoxify azo dye Malachite Green as evaluated by the effects of the bioremediated
47 Malachite Green dye on seed germination and seed development.

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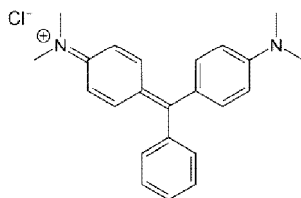
49 2. MATERIALS AND METHODS

50 2.1 Collection and Storage of the Sample:

51 Wastewater was collected from different textile industries located in Sathia, Sirajgonj, Gazipur,
52 Madhapdi, Narshingdhi, Bangladesh. Samples collected from textile industries were in the form
53 of liquid wastewater and sludge. All samples were collected in sterile plastic bottles and
54 polyethylene bags and then stored at 4°C in the refrigerator to avoid changes in their
55 physicochemical properties.

56 2.2 Dyes and Culture Media:

57 Malachite Green dye was purchased from DysinChem limited, Dhaka, Bangladesh.



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Fig. 1. Malachite Green

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61 2.3 Isolation and Screening of Dye decolorizing bacteria:

62 The potent bacteria were isolated from collected samples by LuriaBertani (LB) enrichment
63 medium culture technique modified with 20 ppm of Malachite Green dye for microbial
64 adaptation. Bacterial colonies showed a clear discolored area around them on LB agar were
65 collected and cultured for 24 h in MS medium modified with 1 ml/1 TE dissolution. The growth of
66 bacterial colonies was observed after 24 h of incubation at 35°C. Effect of dyes on the growth of
67 bacterial strains was determined in MS medium supplemented with 20 ppm of Malachite Green
68 dye.

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70 2.4 Genomic DNA Extraction & 16S rDNA Gene Amplification:

71 Genomic DNA was extracted from dye decolourizing bacteria using CTAB method [23]. The
72 PCR primers used to amplify 16S rDNA fragments were the bacteria-specific primers a forward
73 primer 8F (5'-AGA GTT TGA TCC TGG CTC AG-3'; Tm: 61°C); and a reverse primer 806R (5'-
74 GGA CTA CVS GGG TAT CTA AT-3'; Tm: 67.4°C). A total of 25 µl of reaction mixture consisted
75 of – water 15µl, MgCl₂ 2.5µl, buffer 2.5, dNTPs 0.5µl, template 1µl, primer (forward 2 µl and
76 reverse 2 µl). The PCR amplification was performed by Swift™ Minipro Thermal Cycler (Model:

77 SWT-MIP-0.2-2, Singapore) using the following program: Denaturing at 95°C for 5 minutes,
78 followed by 40 cycles of 40 seconds of denaturing at 95°C, 60 seconds of annealing at 65°C
79 and 2 minutes of elongation at 72°C with a final extension at 72°C for 10 minutes. Then, the
80 PCR products were subjected to 1% agarose gel electrophoresis, stained with ethidium bromide
81 and visualized on a UV transilluminator for the presence of about 1500 bp PCR products.

82 The amplified PCR product was purified using AccuPrep® Gel Purification Kit (Bioneer
83 Company, Korea) according to the manufacturer's protocol. PCR amplified 16S rDNA of the
84 isolates screened as submitted for automated sequencing (Applied Biosystems 3130) at the
85 Center for Advanced Scientific Research (CARS) of the University of Dhaka, Bangladesh. the
86 sequence generated from the automatic sequence of PCR amplified DNA analyzed by NCBI
87 BLAST Program (<http://www.ncbi.nlm.nih.gov>) for discover a similar organism possible through
88 association of similar sequences. Finally, the isolates were determined based on partial
89 sequence alignment of 16S rDNA with sequences available in database.

90 **2.5 Sequencing of 16S rDNA and BLAST Analysis:**

91 The nucleotide sequence of the 16S rDNA was sequenced on both sides through the BigDye
92 chain termination cycle sequencer (ABI) and the sequence was decoded on Dideoxy Sanger
93 3130XL String Genetic Analyzer (ABI). The final method was then assembled by the Cap3
94 program for genetic sequencing. Gene sequence was determined by looking for similarities in
95 the database via BLASTn for 16S rDNA.

96 **2.6 Effect of Different Parameters on Process of Dye Decolorization:**

97 Effect of initial dye concentration on discoloration of Malachite Green dye by isolated bacteria
98 was tested after 96 h incubation as described previously [17]. In short, to examine the effect of
99 different dye concentrations on color change, MS medium supplemented with 100, 200, 300 and
100 400 ppm Malachite Green dye was adjusted to pH 7. Then, the medium was inoculated with
101 bacterial strains incubated at 35 °C for 192 h.

102 **2.7 Measurement of Decolorization Efficiency:**

103 The decrease in absorbance at absorption maxima (λ_{max}) was monitored using a UV-visible
104 spectrophotometer to evaluate decolorization activity in terms of % decolorization. Uninoculated
105 MS medium supplemented with corresponding dyes were used as a reference. At different time
106 interval, 2 ml of sample was taken from reaction mixture and centrifuged at 10000 rpm for 10
107 min for biomass separation. The concentration of dye in the supernatant was determined by
108 monitoring the absorbance at maximum absorption wavelength (λ_{max}) at 660 nm.
109 **Decolorization percentage** was calculated according to the following formula

$$Dye\ Decolourization\ (\%) = \frac{Initial\ absorbance - Final\ absorbance}{Initial\ absorbance} \times 100$$

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111 **2.8 Seed Germination Test:**

112 In this experiment, the effect of four concentrations of Malachite Green dye were assessed on
113 the seed germination of five crops viz. Rice (*Oryza sativa*), Wheat (*Triticum aestivum* L.),
114 Khesari (*Lathyrus sativus*), Mustard (*Brassica Nigra*) and Bitter Melon (*Momordica charantia*).
115 **Healthy and uniform seeds were washed with distilled water. The seeds were treated with 0.2%**

116 mercuric chloride for 2 minutes, followed by rinsing with autoclaved distilled water to remove
117 mercuric acid [24]. Then, seeds of each crop were soaked with solutions of different dye
118 concentrations (50, 100, 200 and 400 ppm) for 12 hours. Then 10 seeds of each crop were
119 placed on Whatman filter paper in sterilized Petri plate. The filter papers were moistened with 5
120 ml distilled water (control) or at different concentrations of dye in distilled water every 12 hours.
121 All dishes were stored at room temperature (28 ± 2 C). In another independent experiment, 200
122 ppm dyes were treated with bacterial isolates in 96 hours. After 96 hours, the treated dye was
123 used for seed germination experiments as described above.

124 Number of seeds responded for germination was observed on 8th day and growth was also
125 observed. The shoot length of the seedlings was recorded at every 48 hours for 15 days. Fresh
126 mass and root length of the seedlings were determined after 15 days. The seedlings were
127 uprooted and washed thoroughly with distilled water and lengths of root were measured.

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129 The germination percentage was measured using the following formula [25]

$$Germination(\%) = \frac{Number\ of\ seed\ germinated}{Total\ Number\ of\ seeds\ set\ for\ test} \times 100$$

130 Phytotoxicity of the dye effluent on seedling growth was calculated by using the following
131 formula [26].

$$Phytotoxicity(\%) = \frac{Radical\ length\ of\ control - Radical\ length\ of\ test}{Radical\ length\ of\ control} \times 100$$

132 Seedling vigor index was calculated using the following formula [27].

$$Vigor\ Index = Germination\ Percentage \times Length\ of\ Seedling$$

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$$Germination\ Index = \frac{No.\ of\ seeds\ germinated\ at\ first\ count + \dots + No.\ of\ seeds\ germinated\ in\ last\ count}{Days\ of\ First\ Count + \dots + Days\ of\ Final\ Count}$$

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143 **3. RESULTS**

144 **3.1 Physico-Chemical Characteristics of Textile Effluent**

145 In the present study, physico-chemical characteristics of the collected textile effluent was
 146 analyzed and the results were showed in Table-1

147 **Table 1. Physico-chemical characteristics of textile effluent**

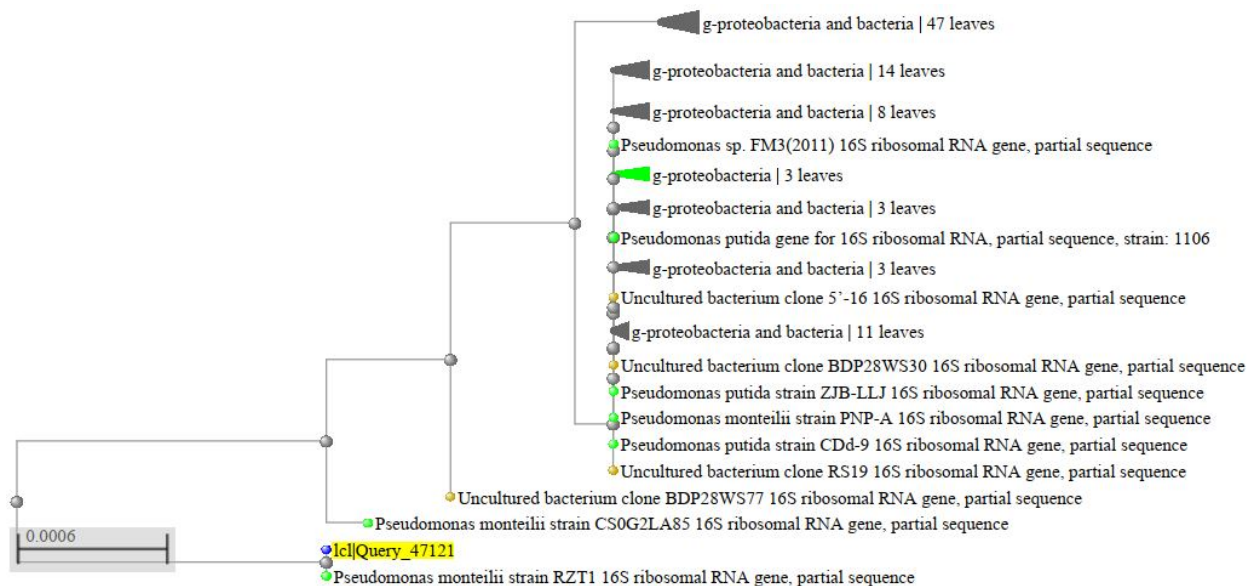
Sr. No:	Source of Sample	TS (mg/l)	TDS (mg/l)	pH	COD (mg/l)	BOD (mg/l)	Temp (°C)	Color	Odor
1	Water	3700	2300	6.3	710	270	35	Black	Foul
2	Sludge	4800	2100	6.8	750	280	35	Black	Foul
3	Water	4300	2500	7.4	620	250	35	Black	Foul
4	Sludge	4100	2700	6.0	785	310	35	Black	Foul

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149 **3.2 Isolation and Identification of Dye Decolorizing Bacteria:**

150 Isolated bacterial strains identified by morphological and biochemical tests were subjected to
 151 16S rRNA gene sequence analysis. Analysis of 16S rRNA gene sequence revealed that the
 152 isolate was *Pseudomonas monteilii* strain RZT1 (Accession Number: OM095453) (Fig. 2).

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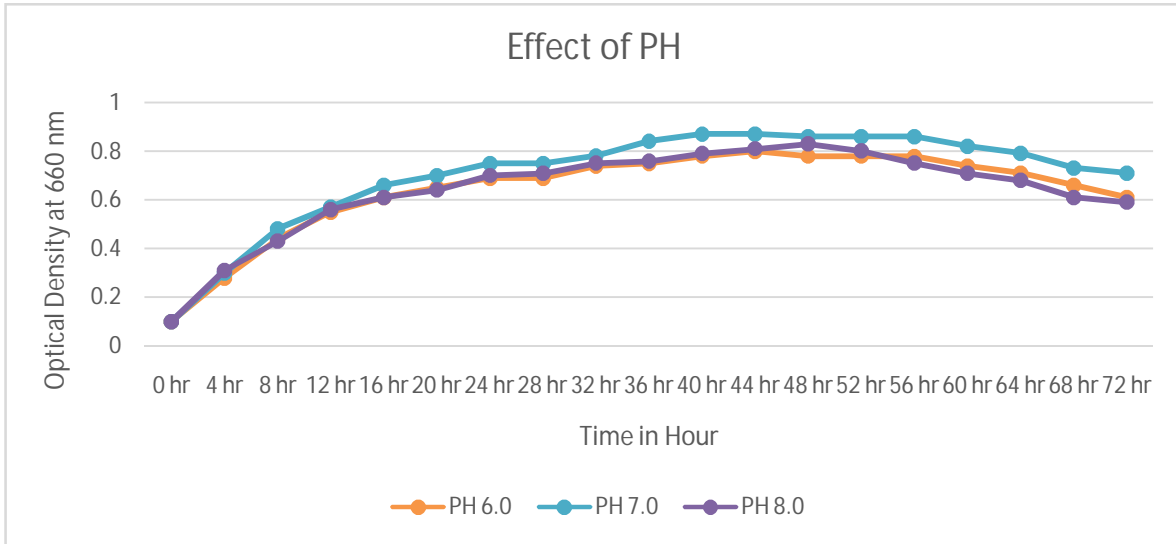
155 Fig. 2. Phylogenetic tree of the *Pseudomonas monteilii* strain RZT1

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158 **3.3 PH and Temperature**

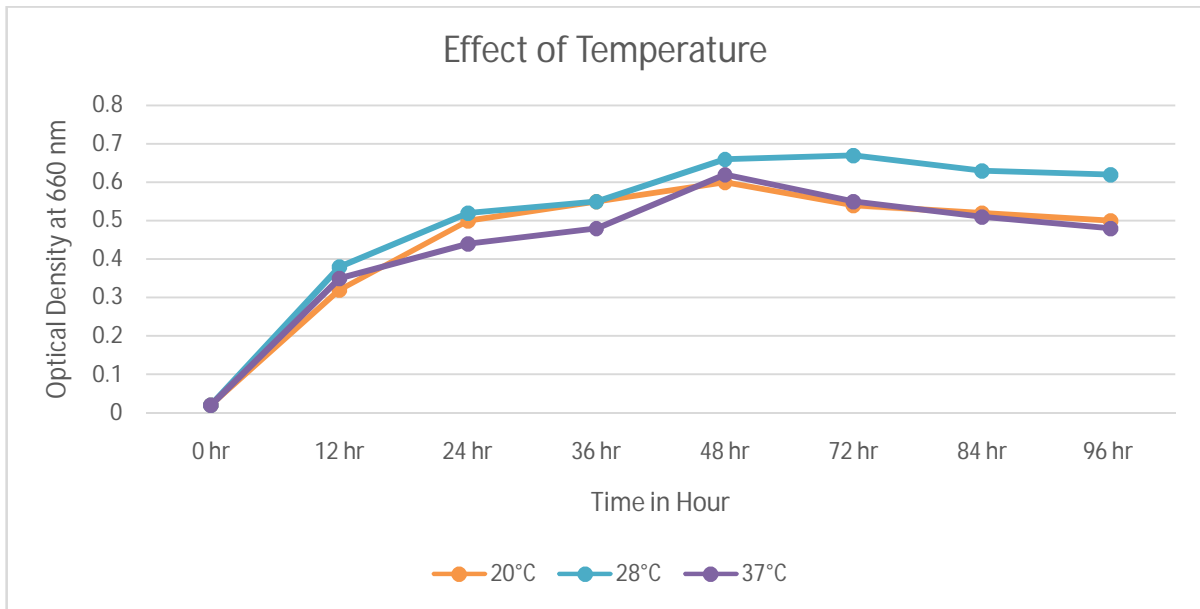
159 In this study, the bacteria having potential to decolorize textile dyes were isolated from collected
160 wastewater of fibers industrial sector. 3 morphologically different bacteria were separated from
161 the wastewater and 1 of them was able to decolorize the Malachite Green dye. This isolates
162 grew optimally at 28° C and pH 7 (Fig. 3 and 4).



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Fig. 3. Effect of PH on bacterial growth



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Fig. 4. Effect of temperature on bacterial growth

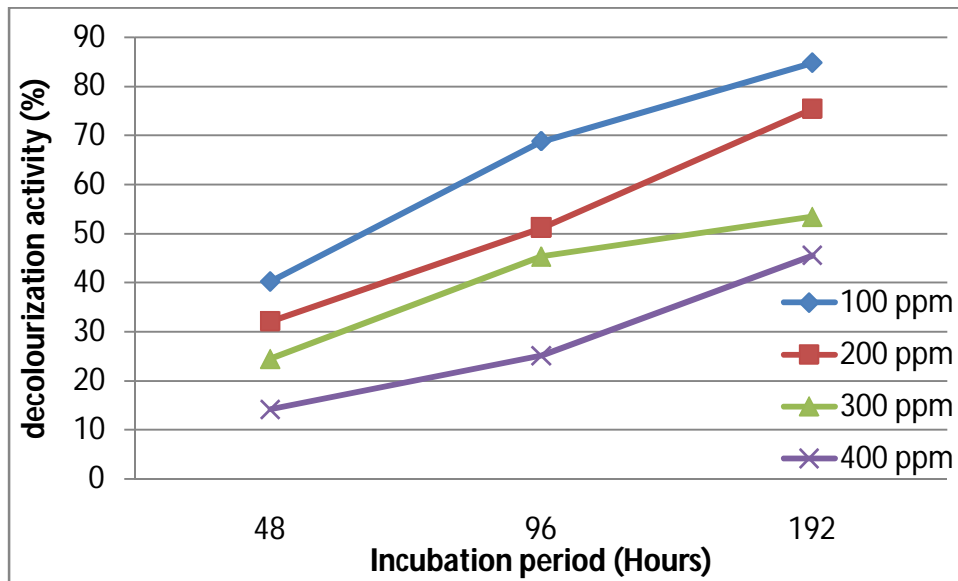
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170 3.4 Effect of Textile Dye Concentration on Decolorization:

171 Effect of initial dye concentration on dye discoloration capability of the bacterial isolate was
172 measured. 0.5% yeast extract was used as a co-substrate. The dye decolourization rate
173 increased with the increase of incubation period. However, dye decolourization percentage
174 decreased with the increase of initial dye concentration (Fig. 5). 84.8%, 75.4%, 63.4% and
175 45.5% decolourization occurred after 192 hours of incubation period at 100, 200, 300 and 400
176 ppm dye concentration.



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178 Fig. 5. Effect of Textile Dye Concentration on Decolorization Activity of malachite green

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180 3.5 Effect of Textile Dye on Seed Germination

181 We investigated the effect of the dye Malachite Green on the seed germination of five crops viz
182 Rice (*Oryza sativa*), Wheat (*Triticum aestivum* L.), Khesari (*Lathyrus sativus*), Mustard
183 (*Brassica Nigra*) and Bitter Melon (*Momordica Charantia*). It was found that the germination
184 rate of seeds decreased with increasing dye concentration (Fig. 6, 7, 8, 9, 10 and 16), indicating
185 that the germination rate was dependent on the concentration. The highest seed germination
186 rate was found in control group (irrigated with water) while the lowest germination rate was
187 observed in seeds irrigated with 400 ppm dye. The germination rate of Rice, Wheat, Mustard,
188 Khesari, and Bitter Melon at 400 ppm dye concentration was 20%, 20%, 20%, 30% and 10%
189 respectively. In this experiment, the seed germination effect of a 200 ppm Malachite Green dye
190 treated (bleached) or untreated with the isolated bacteria was investigated to determine the
191 feasibility of isolated bacteria for crop release. The germination rate of Rice, Wheat, Mustard,
192 Khesari, and Bitter Melon was 40%, 40%, 40%, 40% and 20% respectively when irrigated with
193 200 ppm dye, while those rates were 68%, 65, 55%, 57% and 35% respectively when irrigated
194 with 200 ppm dye treated with bacterial isolate *Pseudomonas monteilii* strain RZT1. The
195 germination rate of seeds soaked with untreated dye was significantly lower than that of seeds
196 soaked with treated dye and distilled water (control) indicating that the isolate *Pseudomonas*
197 *monteilii* strain RZT1 was able to reduce the toxic effects of the dye Malachite Green (Fig. 6, 7,
198 8, 9, 10 and 18).

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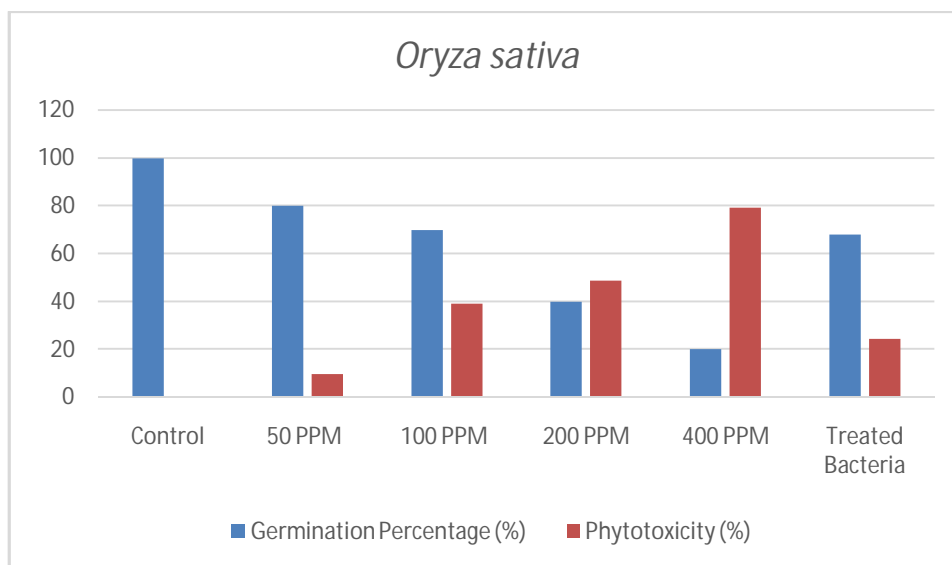


Fig. 6. Germination percentage and phytotoxicity of *Oryza sativa*

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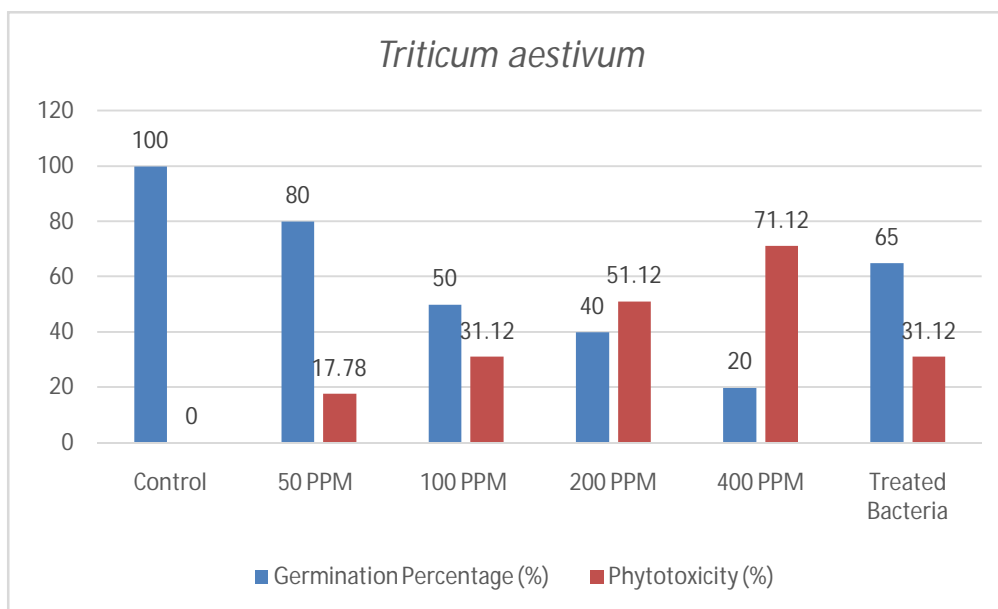


Fig. 7. Germination percentage and phytotoxicity of *Triticum aestivum*

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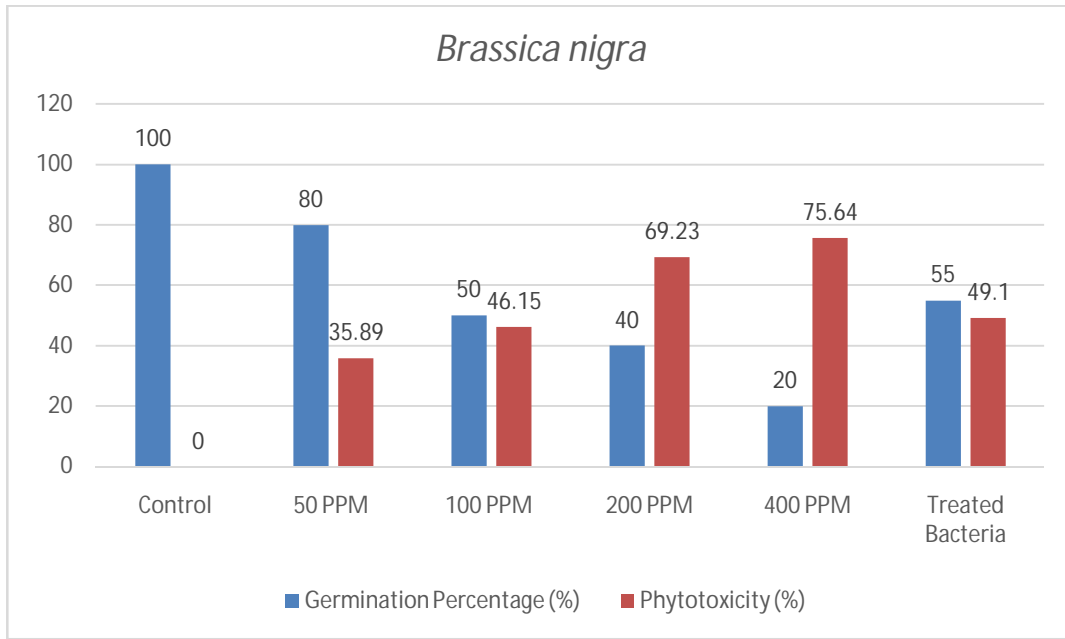


Fig. 8. Germination percentage and phytotoxicity of *Brassica nigra*

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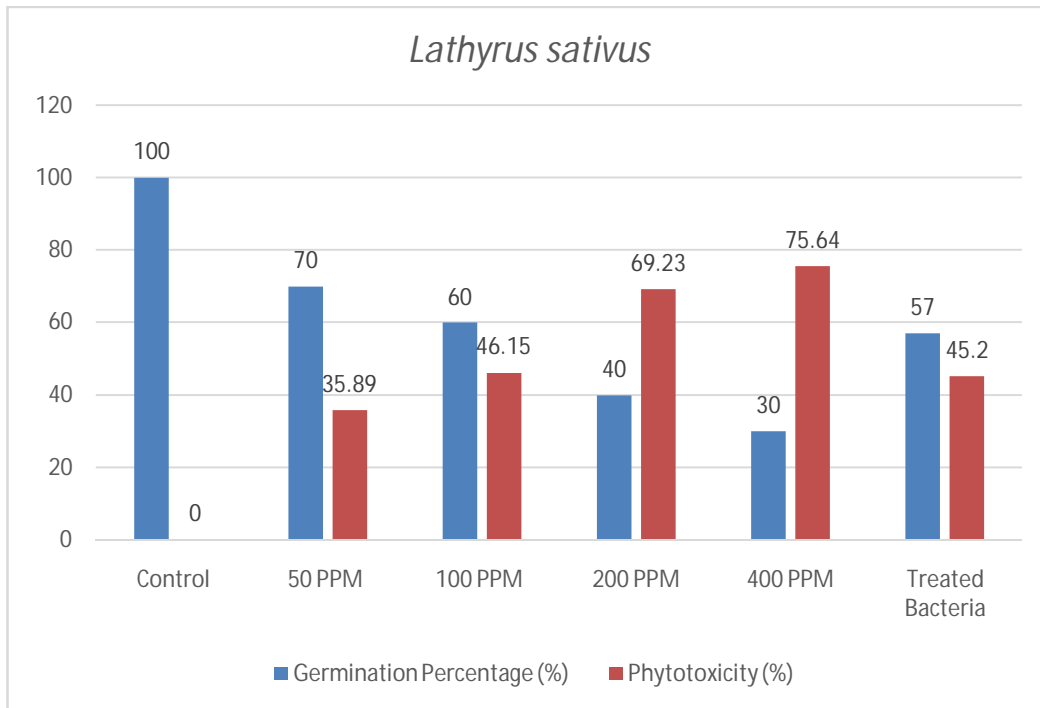


Fig. 9. Germination percentage and phytotoxicity of *Lathyrus sativus*

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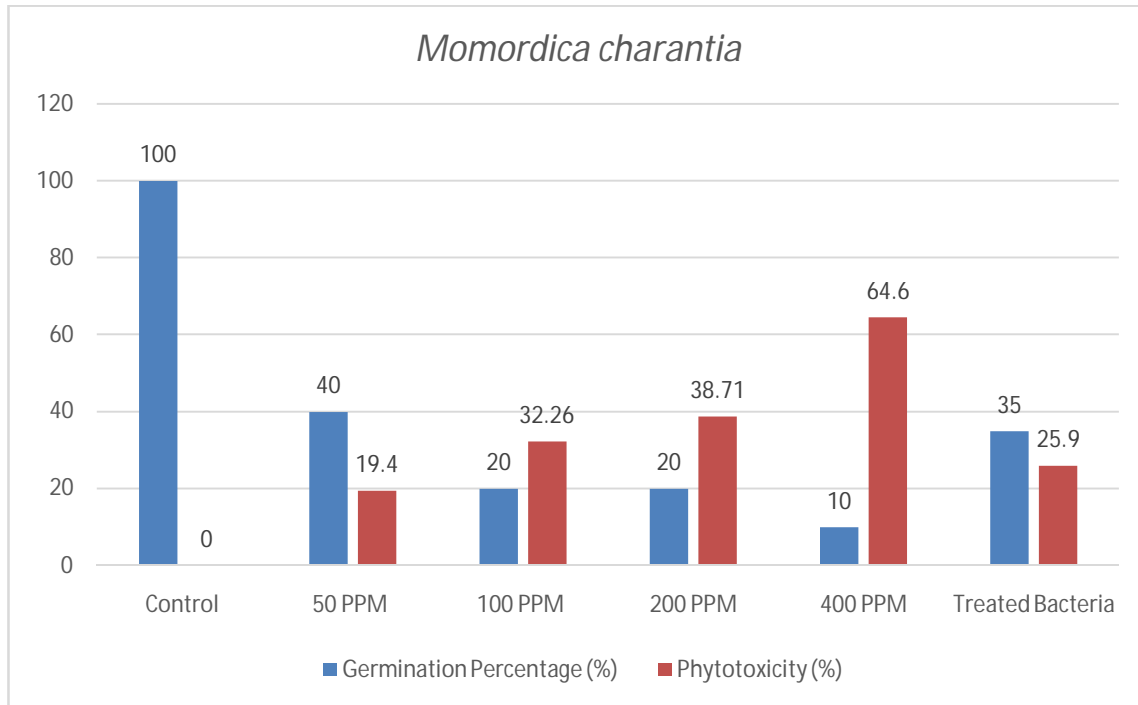


Fig. 10. Germination percentage and phytotoxicity of *Momordica charantia*

3.6 Effect of Textile Dye on Root, Shoot, Seedling and Radical Length of 5 Crops:

Inhibition of plant growth by toxic pollutants is a global agricultural problem. The result of this study revealed that the root, shoot and radical lengths of the 5 studied crops gradually decreased with increase of dye concentration, demonstrating the toxic effect of the Malachite Green dye on these crops growth (Fig. 11, 12, 13, 14, 15 and 17). The highest and the lowest growth of these crops were observed at control and 400 ppm dye concentrations respectively. Maximum root length was observed on control; 10.18, 12.11, 11.30, 11.8 and 13.1 cm for Rice, Wheat, Mustard, Khesari, and Bitter Melon respectively. While minimum root length was obtained at 400 ppm dye concentration; 1.5, 2.1, 3.1, 2.5 and 1.5 cm for Rice, Wheat, Mustard, Khesari, and Bitter Melon respectively. Similarly, maximum shoot length was recorded on control; 15.01, 17.5, 15.2, 14.2 and 15.9 cm for Rice, Wheat, Mustard, Khesari, and Bitter Melon respectively, while minimum shoot length was found for 400 ppm dye; 3.1, 2.8, 4.2, 3.1 and 2.8 cm for Rice, Wheat, Mustard, Khesari, and Bitter Melon respectively. Likewise, maximum radical length was observed on control. There was no significant difference between seedling growth parameters for the control and the lower dye concentration (50 ppm) treatment. But at higher concentration of dye (200 ppm), the growth parameters of seedling was affected negatively which was recovered by the treatment of dye with the bacterial isolate (Fig. 11, 12, 13, 14, 15 and 17).

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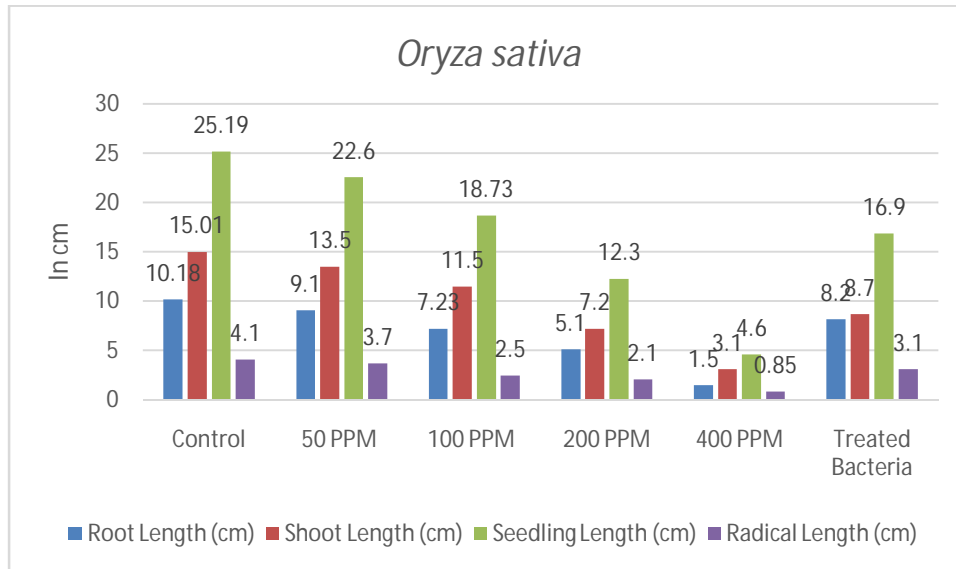


Fig. 11. Root, Shoot, Seedling and Radical length of *Oryza sativa*

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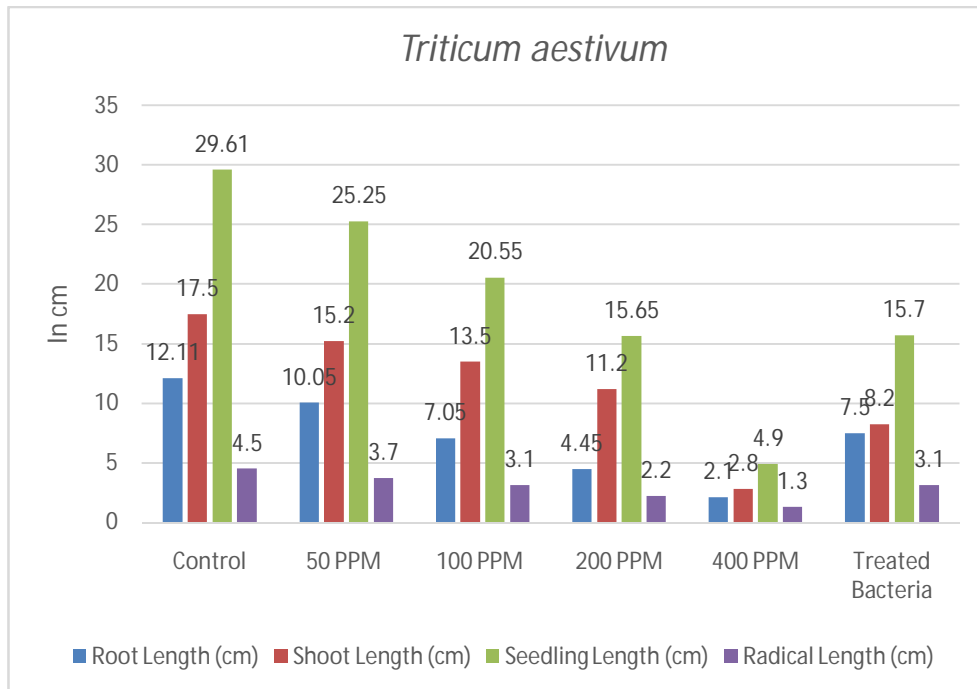


Fig. 12. Root, Shoot, Seedling and Radical length of *Triticum aestivum*

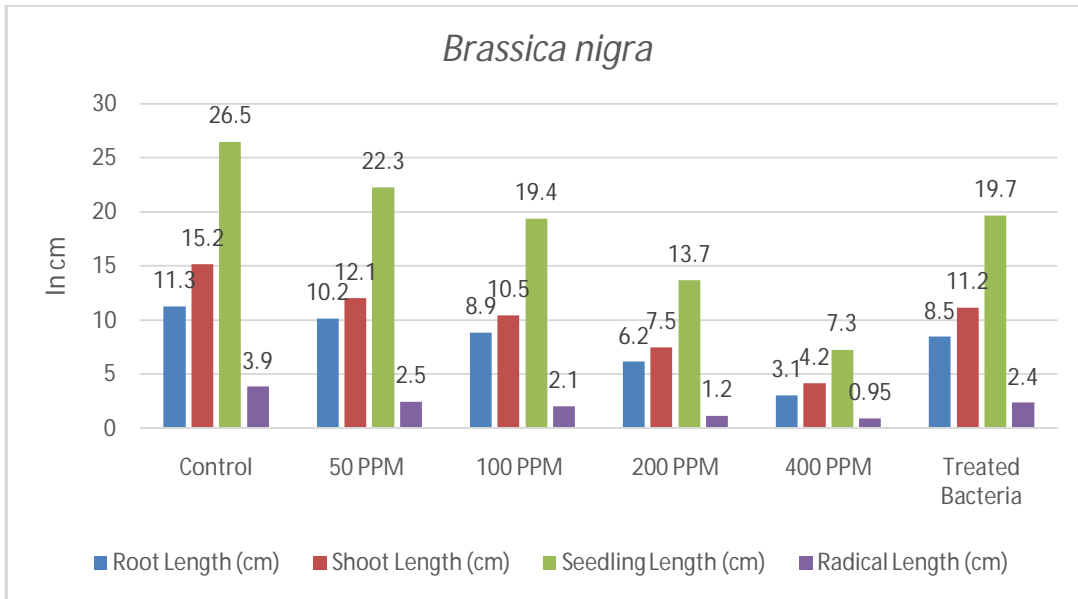


Fig. 13. Root, Shoot, Seedling and Radical length of *Brassica nigra*

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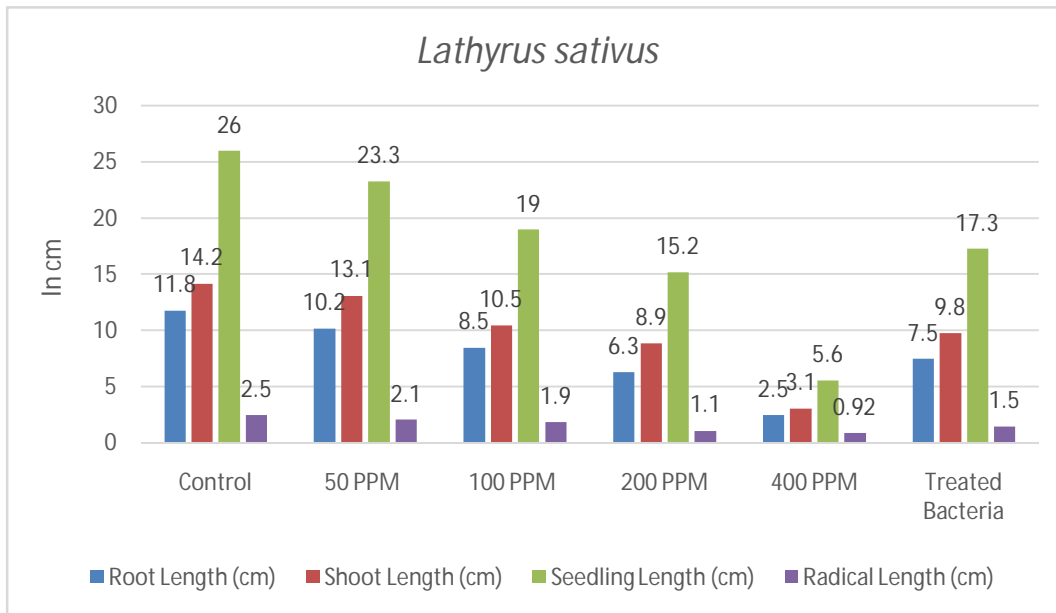


Fig. 14. Root, Shoot, Seedling and Radical length of *Lathyrus sativus*

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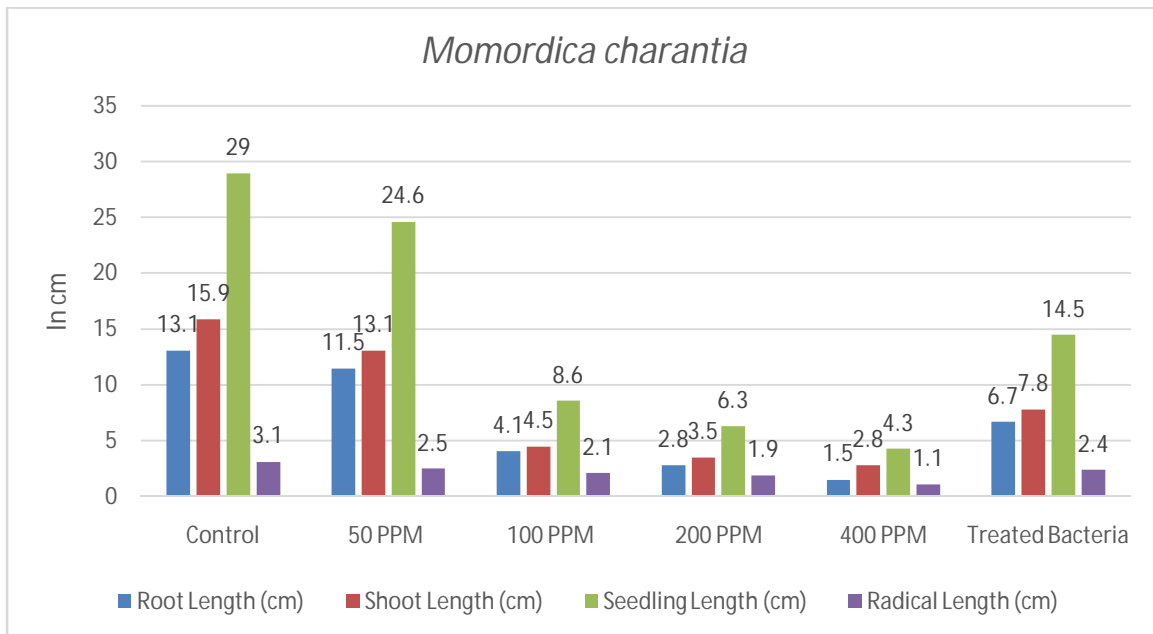


Fig. 15. Root, Shoot, Seedling and Radical length of *Momordica charantia*

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3.7 Effects of Textile Dye on Seedling Fresh Weight

266 The raw weight of seedlings decreased with the increase of dye concentration (Table 2). The
267 best fresh weight of seedlings of control Rice, Wheat, Mustard, Khesari, and Bitter Melon was
268 1.1, 1.2, 1.1, 1.2 and 1.4 gm respectively. Contrary, the lowest fresh weight of seedling of Rice,
269 Wheat, Mustard, Khesari, and Bitter Melon was recorded at 400 ppm dye concentration which
270 was 0.40, 0.31, 0.31, 0.45, 0.51 gm respectively (Table 2).

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3.8 Phytotoxicity of Textile Effluent on Seedling Growth:

274 The **increase of dye** concentration significantly impaired the growth of seedlings (Table 2). The
275 application of **dye** at a higher concentration suppressed the total dry matter production and root
276 length of seedlings. There are no phytotoxicity observed in control but maximum phytotoxicity
277 was observed at 400 ppm dye which were 79.26% 71.12%, 75.6%, 63.2% and 64.6% for Rice,
278 Wheat, Mustard, Khesari and Bitter Melon respectively. In rice 48.78% phytotoxicity was
279 observed at 200 ppm dye concentration while that was 24.39% at 200 ppm treated dye.

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3.9 Seedling Vigor Index and Germination Index:

282 The highest seedling vigor index was observed in control which was 2519, 2961, 2650, 2600
283 and 2900 for Rice, Wheat, Mustard, Khesari, and Bitter Melon respectively. Contrary, the lowest
284 seedling vigor was observed at 400 ppm dye which was 92, 98, 548, 608 and 126 for Rice,
285 Wheat, Mustard, Khesari, and Bitter Melon respectively. In rice, the vigor index was recorded
286 492 at 200 ppm dye concentration, but the vigor index was increased up to 1150 after treatment
287 of 200 ppm dye with the bacterial isolate. For the germination index, similar characteristics was
288 recorded as shown in Table 2.

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Table 2. Fresh weight, vigor index and germination index of different plants at different dye concentration

Name of the Plant	Concentration of the dye	Fresh Weight	Vigor Index	Germination Index
<i>Oryza sativa</i>	Control	1.1	2519	1.34
	50 PPM	0.89	1808	0.89
	100 PPM	0.56	1311	0.78
	200 PPM	0.49	492	0.45
	400 PPM	0.40	92	0.23
	Treated Dye	0.75	1150	0.72
<i>Triticum aestivum</i>	Control	1.2	2961	1.23
	50 PPM	0.75	2020	0.78
	100 PPM	0.62	1027	0.56
	200 PPM	0.41	626	0.45
	400 PPM	0.31	98	0.23
	Treated Dye	0.69	1021	0.68
<i>Brassica Nigra</i>	Control	1.1	2650	1.23
	50 PPM	0.98	1784	1.00
	100 PPM	0.75	970	0.67
	200 PPM	0.45	548	0.45
	400 PPM	0.31	146	0.23
	Treated Dye	0.88	715	0.69
<i>Lathyrus Sativus</i>	Control	1.2	2600	1.45
	50 PPM	1.0	1631	0.89
	100 PPM	0.85	1140	0.78
	200 PPM	0.55	608	0.45
	400 PPM	0.45	168	0.34
	Treated Dye	0.78	912	0.75
<i>Momordica charantia</i>	Control	1.4	2900	1.23
	50 PPM	1.1	984	0.56
	100 PPM	0.93	172	0.34
	200 PPM	0.75	126	0.23
	400 PPM	0.51	43	0.12
	Treated Dye	0.83	168	0.35

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Fig 16: Effect of textile dye on seed germination on *Momordica charantia*

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Fig. 17: Effect of textile dye on seedling length on *Lathyrus sativus*

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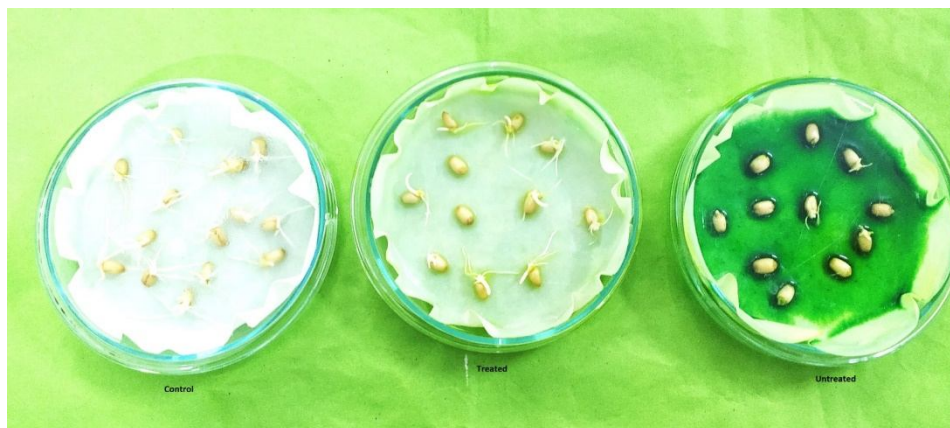


Fig. 18: Effect of treated and untreated dye on seed germination of *Triticum aestivum*

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Fig. 19: Effect of treated and untreated dye on seedling growth of *Momordica charantia*

4. DISCUSSION

“In this study, azo dye decolourizing bacteria *Pseudomonas monteilii* strain RZT1 was isolated and characterized. This bacterial strain was selected after being grown in an enrichment medium supplemented with dye as the sole carbon source as well as in mineral salt medium which confirm the ability of the isolated bacterial species to survive in the presence of the dye. Biodegradation without any extra carbon sources is very difficult. So, optimization experiments were initiated by supplementing the mineral salt medium containing dyes with 0.5% of yeast extract. Metabolism of yeast extract is considered essential for the regeneration of NADH, which is the electron donor for the azo bond reduction” [28]. Azo reductase is reported to be the key enzyme for azo dye degradation.

“At lower dye concentration, bacteria showed maximum decolourization activity. 84.8%, 75.4%, 63.4% and 45.5% decolourization occurred after 192 hours of incubation period in 100, 200, 300 and 400ppm dye concentration. Decrease in decolourization ability at high dye concentration might be due to the toxicity of the dye which was supported by other studies” [16]. “Azo dyes generally contain one or more sulphonic-acid groups on aromatic rings, which might act as detergents to inhibit the growth of microorganisms” [16]. “Another reason of the toxicity at higher concentration may be due to the presence of heavy metals (metal-complex dyes) and the presence of non-hydrolyzed reactive groups which may retard the bacterial growth (reactive dyes)” [29]. Our results revealed that a substantial decrease of different parameters of plants *i.e* germination percentage, radical length, various attributes of root development, fresh weight, phytotoxicity, vigor Index, germination index at higher concentrations of textile dyes. Our results are in agreement with some earlier reports which have also demonstrated a same response of plants when irrigated with effluent [30-34]. Suppression of germination can be caused by reduced water intake by seeds with high concentrations of wastewater, which ultimately affects energy-forming compounds [35] total solids and heavy metals [36, 37].

332 “The study showed clear inhibition of different parameters of seedlings. The germinated seeds
333 did not get enough oxygen for the toxicity of effluent solution and the radical continuously
334 remained in direct contact with the effluent might be responsible for affecting cell multiplication
335 or the growth” [35]. “The lower effluent concentration might promote the growth because of
336 containing plant nutrients” [38]. “This result was in line with the findings of the other who
337 obtained a decreasing length of radical (23.43–0.90 cm) and plumule (16.40–2.20 cm) of five
338 paddy cultivars with increase of effluent concentration” [39, 40]. “Many researchers observed
339 inhibitory effects of various effluents on radical and plumule length of different plant species”
340 [27, 41-44].

341 The germination percentage of this study was supported by the findings of another study [39]
342 who found a decreasing rate of rice seed germination ranging between 100.00–41.50% among
343 five cultivars. Previous researchers also found the same trend of germination percentage with
344 the increasing levels of effluent [39, 45]. This result on fresh weight was in conformity with
345 previous reports [44, 46, 47]. “The promotion of sapling growth by lower concentration of
346 effluents might be due to creating a favorable environmental condition for the germination
347 utilizing the nutrients present in the effluent” [48, 49]. “Due to the high pH, EC, TDS and metallic
348 contents of loom-dye effluent, high level of phytotoxicity might be occurred. Similar toxic effects
349 of industrial effluent were observed by others” [1, 44]. “Previous reports also showed higher
350 vigor index with a lower effluent concentration” [44, 45].

351

352 **5. CONCLUSION**

353 It was found that physio-chemical characteristics of the textile dye had negative impact on
354 germination and seedling growth of economical crops of Bangladesh. But, decolourization and
355 neutralization of textile dye by the treatment of the bacterial isolate *Pseudomonas monteilii*
356 strain RZT1 caused significant reduction of the deleterious effects of textile dye on the
357 germination percentage and seedling growth parameters. Taken together, it can be concluded
358 that the isolate *Pseudomonas monteilii* strain RZT1 could be used as novel bacteria for
359 decolourization and detoxification of textile effluents in industrial treatment plant to ensure
360 ecofriendly environment and sustainable development.

361

362 **6. COMPETING INTERESTS**

363 Authors have declared that no competing interests exist.

364

365 **7. REFERENCES**

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