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PRE-SOWING BIO-PRIMING OF RADISH SEED: GENOTYPIC RESPONSE

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ABSTRACT

Seeds of five radish genotypes were bio-primed with *Pseudomonas fluorescens* and *Trichoderma viride* separately and sown in field following RBD with factorial concept with three replications along with non-primed control. Change in performance of the genotypes for vegetable yield and its attributes were assessed due to priming with both the inoculants. Seed quality enhancement, particularly through germination (%) and vigour index, were assessed in laboratory condition for both inoculated and un-inoculated seeds of all the genotypes. Maximum root length (29.48 cm), fresh weight (2.810 g), dry weight (0.173 g) and vigour index (3651.32) was noted for Mino Early Takii Seeds while Mino Early Hunglong showed maximum shoot length (10.50 cm) in laboratory condition. Influence of *P. fluorescens* was superior over *T. viride* for shoot length, fresh-dry weight while it was reverse for root length and vigour index. Greater influence of *P. fluorescens* was also noticed for fresh-dry weight at both 25 and 50 days after germination. The trend in enhancement over control varied among the genotypes for both seed quality parameters as well as crop performance indicating that response of individual genotypes towards bio-inoculants utilized in this experiment is dependent on its genetic architecture.

INTRODUCTION

Radish is a quick growing and short duration traditionally winter vegetable crop originated in Europe and Asia (Thompson and Kelly, 1957). It is a popular root vegetable in both tropical and temperate regions. Radish is grown for its young tender tuberous root which is consumed either cooked or raw as salad. It is a good source of Vitamin A, Vitamin C (Ascorbic acid) and minerals like calcium, potassium, iron and phosphorus.

Rapid germination and emergence is an important determinant of successful establishment (Heydecker *et al.*, 1973, 1975). Seed priming is one of the most important developments to help rapid and uniform germination, and emergence of seeds as well as to increase tolerance to adverse environmental conditions (Harris *et al.*, 1999). Seed treatment with biocontrol agents along with priming agents may serve as an important means of managing many of the soil- and seed-borne diseases, the process often known as 'bio-priming' (Reddy, 2013). Bio-priming of seeds with bacterial antagonists increases the population load of antagonist to a tune of tenfold on the seeds, thus protecting rhizosphere from the ingress of plant pathogens (Callan *et al.*, 1990). *Pseudomonas fluorescens*, a plant growth promoting Rhizobacteria (PGPR), is known to produce plant growth promoting substances such as indole acetic acid and Gibberellic acid and solubilizes insoluble phosphate (Suneesh, 2004; Megha, 2006) which facilitate plant growth and yield. It plays an important role in stimulating root growth thereby enhancing the nutrient uptake which in turn increases the plant growth (El-Mohamedy *et al.*, 2011). Esitken *et al.*, 2010 also reported increased growth and biomass of a crop plant as a result of inoculation with PGPR strains. *Trichoderma viride* is a fungus which produces antibiotics such as gliotoxin, viridin, cell wall degrading enzymes and biologically active heat stable metabolites such as ethyl acetate (Khan *et al.*, 2004) which are involved in disease suppression and plant growth promotion. It is also known to provide plants with useful molecules such as glucose oxidase and growth stimulating compounds that can enhance the plant growth (Brunner *et al.*, 2005; Gravel *et al.*, 2006). Positive effect of biocontrol agents has been reported on plant growth, yield (Rai and Basu, 2014; Singh *et al.*, 2013) as well as on reduction of disease severity (Singh *et al.*, 2013; Asha *et al.*, 2011; Kumar *et al.*, 2012).

Bio-priming with biocontrol agents offers the grower an alternative to chemical fungicides, thus making it eco-friendly. Knowledge on response of different crops towards priming with various biocontrol agents will be of immense use to seed industry as well as to the farming community. Keeping this in view, the present experiment was conducted to assess the effect of *P. fluorescens* and *T. viride* on different radish genotypes in respect of both seed quality enhancement as well as crop performance.

MATERIALS AND METHODS

The field experiment was conducted during 2010-11 at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia and West Bengal. The experiment was laid out as Randomized Block Design (RBD) with factorial concept in three replications using five radish genotypes *viz.*, V1 [Mino Early (Long White) Hunglong], V2 [Mino Early (Long White) Takii

Seeds], V3 (Early Pink), V4 (Chinese Pink) and V5 (Ghatal Aus), and three treatments which were T1 (Un-inoculated control), T2 (inoculation with *P. fluorescens)* and T3 (inoculation with *T. viride).* Seeds of these genotypes were primed with *P. fluorescens* @10 g/Kg of seeds and with *T. viride* @ 2 g/ 100 g of seeds (Anon., 2007) separately with care following the prescribed procedure, dried in shade followed by sowing of those primed seeds along with un-inoculated control in the field. Field experiment on radish was continued upto the stage of vegetable consumption. Randomly five plants were uprooted from each sub-plot separately at 25 and 50 days after germination (DAG) very carefully for making observations on its root- shoot length and fresh- dry weight.

The standard germination test of bio-primed seeds was carried out in laboratory in three replications along with control adopting the 'Top of Paper' method as per the procedure given by ISTA Rules (Anon., 1996). Germination (%), root-shoot length and fresh-dry weight of seedlings were recorded at final count (6 days after sowing). Randomly ten normal seedlings were separated for recording observations on seedling parameters. Vigour Index was computed after Abdul-Baki and Anderson (1973) as germination (%) x average seedling length.

RESULTS AND DISCUSSION

Seeds of five genotypes of radish were inoculated with *P. fluorescens* and *T. viride* separately to observe influence of both the bio-inoculants on its germination behavior and seedling growth as well as on crop performance. It could be noticed that seedling parameters along with germination (%) and vigour index varied significantly amongst the genotypes and treatments; significant interaction effects could also be noticed for all the parameters studied excepting germination (%) and fresh weight of seedlings. With regard to crop performance at both 25 and 50 DAG, significant differences was noticed for genotypic performance, treatment influence was also significant for the parameters studied, while significant interaction effect was recorded for fresh weight only at both the stages of crop growth.

Effect of bio-priming on seedling parameters

Average germination (%) was recorded as maximum for Ghatal Aus and it was followed by Chinese Pink and Early Pink, though the performance of these three genotypes was statistically indifferent with each other (Table 1). While highest vigour index, on an average, was determined for Mino Early Takii Seeds followed by that of Mino Early Hunglong, though these two exhibited lower germination potential; higher vigour index may be due to its longer seedling production. Average influence of *T. viride* was significantly greater for vigour index than that of *P. fluorescens* which was in harmony with the work done by Shanmugaiah *et al.*, 2009, while influence of the two bio-inoculants could not be differentiated for germination (%) and both the treatments were significantly superior to control for both the parameters (Tables 1&2). It could be revealed through Table 1 that average seedling shoot length was significantly longest for Mino Early Hunglong, while average longest root of seedlings was noted for Mino Early Takii Seeds. Better influence of both the bio-primings could be noticed over the control and superior influence of *P. fluorescens* could be recognized over that of *T. viride* for shoot length, while it was reverse in case of root length. Both fresh and dry weight was significantly highest for Mino Early Takii Seeds and influence of *P. fluorescens* was noted as greater than that of *T. viride(Table2).*

Effect of bio-priming on crop performance

Similar to seedling parameters, significant variation among the genotypes was noticed for average root-shoot length as well as fresh-dry weight of produce. Average influence of bio-priming could also be noticed significantly for expression of the same. At 25 DAG, average shoot length was found to be significantly maximum for Ghatal Aus with greater influence of *P. fluorescens* over that of *T. viride*. Average longest root was harvested for Mino Early Takii Seeds and root length was noted as maximum after seed priming with *T. viride* compared to that with *P. fluorescens*. Significantly higher amount of total fresh vegetable was harvested after the genotype Ghatal Aus at 25 DAG; performance of Mino Early Takii Seeds was similar to that of Ghatal Aus. Consideration of individual response indicated that fresh weight was maximum for Ghatal Aus, when priming was done with *P. fluorescens* and the genotypes responded in a better way towards *P. fluorescens* for higher fresh weight in comparison to that towards *T. viride,* Mino Early Takii Seeds was the exception in responding similarly towards both the inoculants. Significantly maximum dry weight

Table 1: Germination (%), shoot length and root length of radish genotypes as influenced by pre-sowing bio-priming of seeds

Variety / Treatment	Germination (%)				Shoot Length (cm)				Root length (cm)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
Mino Early (Long white) Hunglong	83.33(65.95)	85.00(67.21)	91.67(73.41)	86.67(68.86)	9.30	10.50	9.70	9.83	21.96	25.12	25.80	24.29
Mino Early (Long white) Takii seeds	83.33(65.95)	93.33(75.24)	93.33(75.24)	90.00(72.15)	8.55	10.37	9.65	9.52	26.03	27.90	29.48	27.80
Early Pink	91.67(73.41)	94.97(78.95)	96.63(80.78)	94.42(77.71)	8.33	8.82	8.70	8.61	14.78	15.98	17.45	16.07
Chinese Pink	91.67(73.41)	96.63(80.78)	98.27(84.49)	95.52(79.56)	6.83	9.10	8.08	8.00	18.23	18.46	18.61	18.43
Ghatal Aus	93.33(75.24)	96.63(80.78)	98.27(84.49)	96.08(80.17)	8.58	10.31	9.05	9.31	18.69	19.56	21.31	19.85
Mean	88.67(75.24)	93.31(76.59)	95.63(79.68)		8.32	9.82	9.04		19.94	21.40	22.53	
	V	T	VT		V	T	VT		V	T	VT	
S.Em ±	2.27	1.76	3.93		0.14	0.11	0.25		0.33	0.26	0.58	
CD(P=0.05)	4.63	3.59	-		0.29	0.22	0.50		0.68	0.53	1.18	
CD(P=0.01)	6.24	4.83	-		0.39	0.30	0.68		0.92	0.71	1.59	

T1 = Untreated control, T2 = Bio-priming with *Pseudomonas fluorescens*, T3 = Bio-priming with *Trichoderma viride* (Values in parenthesis indicate arc-sin transformed)

Table 2: Fresh weight, dry weight and vigour index of radish genotypes as influenced by pre-sowing bio-priming of seeds

Variety / Treatment	Fresh weight (g)				Dry weight (g)				Vigour Index			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
Mino Early (Long white) Hunglong	2.100	2.467	2.350	2.306	0.103	0.147	0.137	0.129	2604.02	3027.42	3254.33	2961.92
Mino Early (Long white) Takii seeds	2.427	2.810	2.610	2.616	0.123	0.173	0.147	0.148	2879.43	3571.58	3651.32	3367.44
Early Pink	1.323	1.510	1.413	1.416	0.043	0.080	0.047	0.057	2117.80	2355.15	2526.15	2333.03
Chinese Pink	1.200	1.767	1.507	1.491	0.037	0.160	0.053	0.083	2296.20	2664.34	2623.52	2528.02
Ghatal Aus	1.543	2.160	2.107	1.937	0.083	0.110	0.090	0.094	2544.03	2887.30	2984.21	2805.18
Mean	1.719	2.143	1.997		0.078	0.134	0.095		2488.30	2901.16	3007.90	
	V	T	VT		V	T	VT		V	T	VT	
S.Em ±	0.059	0.045	0.102		0.007	0.005	0.011		48.35	37.45	83.74	
CD(P=0.05)	0.120	0.093	-		0.014	0.010	0.023		98.74	76.49	171.03	
CD(P=0.01)	0.161	0.125	-		0.018	0.014	0.032		132.96	102.99	230.29	

T1 = Untreated control, T2 = Bio-priming with *Pseudomonas fluorescens*, T3 = Bio-priming with *Trichoderma viride*

Table 3: Influence of seed bio-priming on radish genotypes for crop performance at 25 days after germination (DAG)

Variety / Treatment	Shoot Length (cm)				Root length (cm)				Fresh weight (g)				Dry weight (g)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
Mino Early (Long white) Hunglong	9.24	11.58	10.18	10.33	10.23	12.40	12.50	11.71	19.00	21.50	19.67	20.06	9.50	10.17	9.50	9.72
Mino Early (Long white) Takii seeds	9.72	10.85	10.33	10.30	11.76	12.79	12.89	12.48	18.50	22.00	21.17	20.56	9.00	9.83	9.33	9.39
Early Pink	9.74	11.14	10.39	10.42	10.10	11.70	12.37	11.39	17.50	20.00	18.33	18.61	6.67	8.17	7.00	7.28
Chinese Pink	9.47	10.46	9.74	9.89	10.30	11.18	11.79	11.09	15.67	20.50	18.67	18.28	6.00	7.67	7.00	6.89
Ghatal Aus	10.37	11.70	11.10	11.06	11.18	12.62	13.10	12.30	20.00	22.17	20.83	21.00	7.50	8.67	7.83	8.00
Mean	9.71	11.15	10.35		10.71	12.14	12.53		18.13	21.23	19.73		7.73	8.90	8.13	
	V	T	VT		V	T	VT		V	T	VT		V	T	VT	
S.Em ±	0.25	0.19	0.43		0.22	0.17	0.38		0.25	0.19	0.42		0.29	0.23	0.51	
CD(P=0.05)	0.50	0.39	-		0.45	0.35	-		0.50	0.39	0.87		0.60	0.47	-	
CD(P=0.01)	0.68	0.53	-		0.61	0.47	-		0.68	0.52	1.17		0.81	0.63	-	

T1 = Untreated control, T2 = Bio-priming with Pseudomonas fluorescens, T3 = Bio-priming with Trichoderma viride

Table 4: Influence of seed bio-priming on radish genotypes for crop performance at 50 days after germination (DAG)

Variety / Treatment	Shoot Length (cm)				Root length (cm)				Fresh weight (g)				Dry weight (g)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
Mino Early (Long white) Hunglong	31.87	33.00	32.27	32.38	23.87	25.27	26.20	25.11	920.33	1016.33	974.50	970.39	59.50	70.33	67.67	65.83
Mino Early (Long white) Takii seeds	31.27	33.87	32.33	32.49	26.07	26.67	27.60	26.78	1017.33	1467.33	1218.50	1234.39	98.50	141.17	116.83	118.83
Early Pink	32.00	34.07	33.67	33.24	22.27	23.33	24.00	23.20	766.83	846.67	827.17	813.56	80.17	98.00	90.17	89.44
Chinese Pink	31.13	32.93	31.53	31.87	21.87	22.60	23.40	22.62	985.00	1046.00	1000.67	1010.56	97.00	115.17	105.17	105.78
Ghatal Aus	41.00	42.53	41.60	41.71	21.60	22.87	24.20	22.89	1057.67	1185.00	1154.83	1132.50	107.00	125.83	116.67	116.50
Mean	33.45	35.28	34.28		23.13	24.15	25.08		949.43	1112.27	1035.13		88.43	110.10	99.30	
	V	T	VT		V	T	VT		V	T	VT		V	T	VT	
S.Em ±	0.42	0.32	0.72		0.31	0.24	0.54		39.19	30.35	67.87		4.23	3.27	7.32	
CD(P=0.05)	0.86	0.66	-		0.64	0.50	-		80.27	62.18	139.03		8.66	6.71	-	
CD(P=0.01)	1.16	0.90	-		0.87	0.67	-		108.30	83.89	187.58		11.68	9.05	-	

T1 = Untreated control, T2 = Bio-priming with *Pseudomonas fluorescens*, T3 = Bio-priming with *Trichoderma viride*

of crop was recognized for both Mino Early Hunglong and Mino Early Takii Seeds. Average influence of *P. fluorescens* was greater for expression of both fresh and dry weight of crop at 25 DAG (Table 3).

Similar to crop growth at 25 DAG, significant variation was also noticed among the genotypes for root-shoot length as well as fresh-dry weight of produce at final harvest of the crop *i.e.*, at 50 DAG (Table 4). Significantly maximum average shoot length was achieved for Ghatal Aus, while it was maximum for Mino Early Takii Seeds while considering the other three parameters, though Ghatal Aus performed statistically in similar manner for dry weight of crop. Greater influence of *P. fluorescens* was prominent than that of *T. viride* for expression of the parameters studied excepting root length (Shanmugaiah *et al.*, 2009) for which reverse scenario could be noticed. A different scenario could be noticed for consideration of individual genotypic performance for fresh weight of the crop with progress in age: significantly similar influence of the inoculants was noticed for all the genotypes, Mino Early Takii Seeds was the exception for which influence of *P. fluorescens* was greater than that of *T. viride*. Genotype specific response could be noticed for expression of individual parameters on consideration of the performance of individual genotypes with the resultant influence of the bio-inoculants at different stages of crop growth.

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