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PRE-SOWING SEED BIO-PRIMING IN OKRA: RESPONSE FOR SEED PRODUCTION

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ABSTRACT
Seeds of eight varieties of okra: Lalu, Arka Anamika, Ramya, Satsira, Lady Luck, Debpusa Jhar, Japani Jhar and Barsha Laxmi were bio-primed with *Trichoderma viride* and *Pseudomonas fluorescens*, and sown in the field in Split-plot Design with three replications along with the unprimed control in two consecutive summer seasons of 2011 and 2012 to assess the variation in response of individual varieties for seed yield and its attributes. *Trichoderma viride* was improved plant length as 108.21cm and 112.25 cm for variety Arka Anamika, maximum pod length *i.e.* 19.01 and 19.21 as well as in pod diameter as 16.64 mm and 16.85 mm for Lalu variety in first and second year respectively. Overall seed yield per plant was as maximum as 49.14g and 51.58g in 2011 and 2012 respectively for Lalu, while it was lowest for Lady Luck (24.13g and 25.69g) in both the years. Expression for response towards individual bio-inoculants for individual varieties varied, which indicate the existence of genotypic response in enhancing the seed yield of individual varieties after pre-sowing bio-primed of seeds.From these findings it can be concluded that the bio-priming with compatible bio-agents will enhance the plant growth and yield attributes.

INTRODUCTION

Okra (*Abelmoschus esculentus)* is one of the most important vegetable crops of the world. It is quite popular in India because of its easy cultivation, dependable yield and adaptability to varying environmental conditions.

Seed priming as one of the most important developments to help rapid and uniform germination and emergence of seeds, and to increase seed tolerance to adverse environmental conditions (Harris *et al*., 1999). Seed priming is now a widely used commercial process that accelerates the germination rate and improves seedling uniformity in many crops (Halmer, 2003; Taylor and Harman, 1990).

Among the different seed priming techniques, off late bio-priming using microbial infusion has been practiced for making priming eco-friendly. Bio-priming is a process of biological seed treatment that refers to combination of seed hydration (physiological aspect of disease control) and inoculation (biological aspect of disease control) of seed with beneficial organism(s) to protect seed. It is an ecological approach using either bacteria or selected fungal antagonists against the soil and seed-borne pathogens. Beginning of the use of bio-control agents because, presently application of chemical pesticide and nutrients create the pressure on humans as well as environmental for their health hazards and also to think their substitute (Nakkeeran *et al.,* 2005). Beneficial free-living soil bacteria enhancing plant growth are generally referred to as plant growth-promoting bacteria and are found in association with the roots of various plants (Kloepper *et al.,* 1991; Sajjad *et al*., 2001; Shanmugaiah, 2005 and Shanmugaiah, *et al.,* 2007). Despite, entophytes, which colonize and reside in internal plant habitats, were proved effective in plant growth promotion and disease control in a wide range of crops (Manjula *et al*., 2002, Sunkad *et al.,* 2012). Overall we can say that a diverse array of bacteria including species of *Pseudomonas, Azospirillum, Azotobacter, Bacillus, Klebsiella, Enterobacter* and *Serratia,* has been found to be effective in enhancing plant growth. *Trichoderma* species are effective in the control of soil/seed borne fungal diseases in several crop plants (Kubicek *et al*., 2001, Selosse *et al*., 2004 and Preston, 2004). Seed treated with *Trichoderma spp*. check the growth of fungal diseases and improve the seed quality. *Trichoderma spp.* has evolved multiple mechanisms resulting in improvements in plant resistance to diseases, plant growth and productivity (Harman *et al*., 2004; Vinale *et al*., 2008). Possible explanation of this phenomenon include: control of minor population of pathogens leading to stronger root growth (Yedidia *et al*., 2001) and nutrient uptake (Das *et al.,* 2014), secretion of plant growth regulatory factors such as phyto-hormones (Muthukumar *et al*., 2005), and release of soil nutrients and minerals by saprophytic activity of *Trichoderma* in soil (Ousley *et al*., 1994). The increased growth response induced by *Trichoderma* sp. has been reported for many crops such as beans, cucumber, pepper, carnation, maize, and wheat

(Lo and Lin, 2002) as well as in yield of sorghum (Kotgire *et al.,* 2012). Increased dry weight and plant height were also recorded with application of *Pseudomonas* sp. MML2212 and *Pseudomonas fluorescens* on rice and green gram when compared with the control (Mathivanan *et al*., 2005, Shanmugaiah *et al*., 2005). Plant-associated microorganisms fulfill important functions for plant growth, such as enhancement of plant growth and protection of plants from various plant pathogens in several crops such as cucumber, radish, tomato, sugar cane, and rice as reported by Viswanathan and Samiyappan (1999), Ongena *et al*. (2000) and Ramamoorthy *et al*. (2001). Growth and yield of the tomato crop enhanced by the both *Trichoderma* and *Pseudomonas* also reported by the Singh *et al.,* (2008).

The main aim of this study was to assess the effect of *Pseudomonas fluorescens* and *Trichoderma viride*, in comparison to control by measuring the growth parameters of okra in field.

MATERIALS AND METHODS

The present experiment was carried out during summer season 2011 and 2012 at District Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to assess the effect of bio-priming on seed production potential of okra eight different okra varieties *viz.,* Lalu, Arka Anamika, Ramya, Satsira, Lady Luck, Debpusa Jhar, Japani Jhar and Barsha Laxmi, collected from different parts of West Bengal and Uttar Pradesh, which were admired for that region. Pre-sowing seed bio-priming was done with two bio-agents *viz., Trichoderma viride* and *Pseudomonas fluorescens*.

Seed treatment (bio-priming) was done with spore suspension of *Trichoderma viride* and conidia suspension of *Pseudomonas fluorescens*, to follow the method of Nayaka *et al.,* (2008). Bio- primed seeds along with unprimed control were sown in field with three replications following Split- plot Design and spacing was maintained as 60cm. × 50 cm. Each row length was of 5 meter and there were five rows per plot for each variety × treatment combination, thus leading to an individual plot size of 5m × 3 m. Two seed were sown in each hole and light irrigation immediately after sowing was done. Thinning was noted at 20 days after sowing (DAS) for maintenance of optimum plant population as well as for proper growth and development of plants. Five plants were randomly selected at 25 days after sowing and marked with aluminium tag to record on seed yield per plant and its attributes

RESULTS AND DISCUSSION

Effect of bio-priming on plant height

Significantly tallest plants were recorded from Ramya and Lady Luck followed by Satsira, Arka Anamika and Lalu irrespective of the years of experiment, and most dwarf plants were recorded from Japani Jhar and Barsha Laxmi. Magnitude in plant height was slightly enhanced for individual varieties in second year than that in first year, may be due to congenial environmental condition prevailed in second year during crop growth. Consideration of influence due to bio-priming on individual varieties indicates that maximum plant height was recorded for Ramya *i.e.,* 108.21 cm. in 2011 and 111.25 cm in 2012, when bio-priming was made with *Trichoderma viride*. This finding has been supported by Rahman, *et al*. (2012), Omar, *et al*. (2007) and Ahmad, *et al*. (2012). Seed bio-priming of Lady Luck with *Trichoderma viride* as well as that of Ramya with *Pseudomonas fluorescens* produced plants statistically at par with Ramya x *Trichoderma viride* over the years. Akhtar, *et al*. (2008), Mansoor, *et al*. (2007), this is accordance with the result of Nettu *et al*. (2012) and Tariq, *et al*. (2009) who's reported that *Pseudomonas* spp. increase the growth of plants.

Effect of bio-priming on number of pods per plant

Maximum numbers of pods, on an average, were harvested for Arka Anamika (18.70 and 19.27) followed by Japani Jhar, Lalu, Barsha Laxmi and Debpusa Jhar in both the years, performance of Debpusa Jhar and Barsha Laxmi were statistically at par. Lowest numbers of pods were produced by Satsira (13.24 and 13.68) in respective years. Significantly greater influence of *Trichoderma viride* could be recognized in both the years and influence of either bio-priming in positive direction over the control was also significant. Number of pods recorded maximum in Japani Jhar (19.29) in first year and Arka Anamika (19.85) in second year due to the bio-priming with *Trichoderma viride*. According to the Shaban, *et al*. (2011) and Ahmad, *et al*. (2012), *Trichoderma* significant enhanced the number of pods in broad bean and okra respectively.

Effect of bio-priming on pod length

Significantly longest pods at final stage were harvested from Lady Luck (18.86 and 19.58 cm) irrespective of the year of experiment followed by Lalu, Ramya, Satsira and Arka Anamika though the later two were statistically at par. Shortest pods were harvested from Barsha Laxmi (12.31 and 12.60 cm) in both the years. Longest pod length were found from Lady Luck (19.29 and 19.58 cm) with pre-sowing bio-priming with *Pseudomonas fluorescens*, significantly longest pods could be harvested in both the years and it was statistically at par with the same variety in same year *Trichoderma viride* was used as bio-primer. The next position was occupied by both Lady Luck (19.00 cm.) and Lalu (19.01 cm.) after bio-priming with *Trichoderma viride* in first year, and bio-priming with *Pseudomonas fluorescens* for Lalu can also be added with the first year for occupying the position in second year. Similar observation also recorded by Rahman, 2012 and they concluded that the longest pod length in chilli has been influenced by *Trichoderma* spp.

Effect of bio-priming on pod diameter

Better influence of *Trichoderma viride* could be recognized for this character in comparison to that of *Pseudomonas fluorescens* in first year and it was reverse in second year (Table 1). Pod diameter was observed maximum in variety Lalu (16.64 and 16.85mm) when seed bio-priming with *Trichoderma viride* followed by the same variety when bio-priming was made with *Pseudomonas fluorescens* in both the years respectively. According to Mohamedy *et al.,* 2008, these bio- agents increased the pod diameter of pea.

Effect of bio-priming on seed yield

Average influence of *Trichoderma viride* was better in both

Table 1: Bio-priming effect on different seed yield attributes of okra varieties

Varieties	Plant height (cm)								Number of pods per plant							
	2011				2012				2011				2012			
	T0	T1	T2	MEAN	T0	T1	T2	MEAN	T0	T1	T2	MEAN	T0	T1	T2	MEAN
V_1	70.17	81.00	78.91	76.70	73.15	83.14	80.00	78.76	16.00	17.21	17.14	16.79	15.96	17.59	17.68	17.08
V_2	82.00	86.11	85.88	84.66	84.15	85.14	88.14	85.81	17.89	19.02	19.19	18.70	18.22	19.85	19.73	19.27
V_3	93.00	108.21	103.84	101.68	95.13	111.25	107.25	104.54	14.09	15.82	15.09	15.00	14.58	16.25	15.77	15.53
V_4	84.67	90.69	88.00	87.79	88.25	95.22	96.25	93.24	12.57	14.06	13.09	13.24	13.00	14.59	13.46	13.68
V_5	94.24	105.46	100.34	100.01	98.25	107.25	102.14	102.55	14.85	15.02	14.00	14.62	15.05	15.88	14.63	15.19
V_6	53.00	60.04	65.11	59.38	55.14	62.85	65.88	61.29	16.46	17.16	14.96	16.19	16.59	17.67	15.44	16.57
V_7	51.09	54.93	57.07	54.37	53.47	56.77	59.25	56.50	17.29	19.29	18.58	18.39	17.28	19.84	19.10	18.74
V_8	51.67	59.77	59.96	57.14	54.11	62.18	62.87	59.72	15.10	16.37	17.09	16.19	15.22	16.97	17.81	16.67
MEAN	72.48	80.78	79.89		75.21	82.97	82.72		15.53	16.74	16.14		15.74	17.33	16.70	
	V	T	V × T		V	T	V × T		V	T	V × T		V	T	V × T	
SEM (±)	1.555	0.832	2.472		1.577	0.879	2.570		0.032	0.020	0.055		0.073	0.048	0.132	
CD at 5%	4.717	2.278	7.269		4.783	2.406	7.550		0.097	0.057	0.163		0.221	0.131	0.386	
Varieties	Pod length (cm)								Pod diameter (mm)							
	T0	T1	T2	MEAN	T0	T1	T2	MEAN	T0	T1	T2	MEAN	T0	T1	T2	MEAN
V_1	18.12	19.01	18.90	18.68	18.28	19.21	19.22	18.90	15.24	16.64	16.44	16.11	15.55	16.85	16.67	16.36
V_2	15.87	16.46	16.36	16.23	16.10	16.68	16.59	16.46	12.58	13.44	12.87	12.97	12.68	13.65	13.06	13.13
V_3	16.21	17.19	17.22	16.87	16.42	17.57	17.38	17.12	13.51	14.01	13.98	13.83	13.75	14.29	14.10	14.05
V_4	15.28	16.83	16.89	16.33	15.65	17.11	17.11	16.62	13.60	13.94	14.09	13.88	16.69	14.02	14.19	14.97
V_5	18.28	19.00	19.29	18.86	18.77	19.24	19.58	19.20	12.08	14.31	13.06	13.15	12.19	13.42	13.05	12.89
V_6	13.40	13.62	13.58	13.54	13.59	13.79	13.78	13.72	13.00	13.20	13.77	13.32	13.52	12.36	13.92	13.27
V_7	14.60	15.07	14.87	14.85	14.84	15.27	14.96	15.02	14.39	14.62	14.69	14.57	14.67	14.77	14.80	14.75
V_8	11.85	12.55	12.54	12.31	12.02	12.89	12.88	12.60	12.17	13.18	13.50	12.95	12.27	13.29	13.66	13.07
MEAN	15.45	16.22	16.21		15.71	16.47	16.44		13.32	14.17	14.05		13.92	14.08	14.18	
	V	T	V × T		V	T	V × T		V	T	V × T		V	T	V × T	
SEM (±)	0.044	0.015	0.056		0.097	0.042	0.137		0.076	0.037	0.114		0.030	0.025	0.065	
CD at 5%	0.134	0.040	0.166		0.294	0.114	0.404		0.231	0.101	NS		0.092	0.071	NS	

V_1-Lalu, V_2-Arka Anamika, V_3-Ramya, V_4-Satsira, V_5-Lady Luck, V_6-Debpusa Jhar, V_7-Japani Jhar, V_8-Barsha Laxmi. T_0-Control, T_1-*Trichoderma viride*, T_2-*Pseudomonas fluorescens*.

Table 2: Seed yield per plant (g) as influenced by bio-priming

Vartieties	2011				2012			
	T0	T1	T2	MEAN	T0	T1	T2	MEAN
V_1	42.409	52.548	52.459	49.138	44.216	54.726	55.804	51.582
V_2	36.025	44.386	44.585	41.665	37.526	47.368	47.397	44.097
V_3	21.840	29.908	27.575	26.441	23.851	32.358	30.336	28.848
V_4	30.755	39.183	37.445	35.794	32.692	41.737	39.337	37.922
V_5	20.716	25.509	26.157	24.127	20.991	27.667	28.397	25.685
V_6	34.182	41.421	35.754	37.119	35.719	44.050	37.737	39.169
V_7	33.197	44.424	41.124	39.581	35.239	48.259	44.069	42.522
V_8	24.110	31.573	33.674	29.786	24.690	33.198	36.777	31.555
MEAN	30.404	38.619	37.347		31.866	41.170	39.982	
	V	T	V × T		V	T	V × T	
SEM (±)	0.405	0.219	0.639		0.308	0.214	0.582	
CD at 5%	1.228	0.586	1.879		0.933	0.573	1.702	

V_1-Lalu, V_2- Arka Anamika, V_3- Ramya, V_4- Satsira, V_5- Lady Luck, V_6- Debpusa Jhar, V_7- Japani Jhar, V_8- Barsha Laxmi. T_0- Control, T_1- *Trichoderma viride,* T_2- *Pseudomonas fluorescens.*

the years and both the bio-primings were proved to possess potential capacity to enhance seed yield over untreated control (Table 2).

The maximum seed yield was found in Lalu (52.55g) when bio-priming with *Trichoderma viride* in first year whereas in second year it was 55.81g with *Pseudomonas fluorescens* from same variety. Lowest seed yield was obtained from Lady Luck (2072 and 20.99g) in both the years respectively in control condition. According to Rudresh *et al*. (2005), seed yield of chick pea enhanced by the application of *Trichoderma* spp. Enhancement in seed yield after application of *Trichoderma* spp. and also same said findings obtained by Shaban, *et al*. (2011) in broad bean whereas lentil seed yield enhanced by the seed coated with *Pseudomonas* (Akhtar, *et al.,* 2008).

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