Seed Res. 51 (1): 55-60, June, 2023

Impact of Bio-priming on Seed Quality Enhancement in Sweet Pepper

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(Received April 2023; Revised May 2023; Accepted May 2023)

ABSTRACT: A laboratory study was undertaken to know the effect of biopriming on seeds with different biopriming agents like humic acid, vermiwash, compost tea, cytozyme seed+, VAM at the concentration of 30% on different vigour lots in sweet pepper at Department of Seed Science and Technology, University of Agricultural Sciences, Bengaluru. Among vigour level, high vigour seed lot was differed significantly with highest seed germination (86.0%), speed of germination (10.42), mean seedling length (8.52 cm), mean seedling dry weight (4.00 mg), seedling vigour index – I (730), seedling vigour index – II (342), total dehydrogenase activity (1.795), total soluble seed protein (72.98 µg/g), amylase activity (89.79 µmol/min) and decreased electrical conductivity of seed leachates (38.55 µS/cm) were recorded. Among the treatments biopriming with compost tea at 30% recorded significantly highest seed germination (84.0%), speed of germination (10.42), mean seedling length (8.65cm), mean seedling dry weight (4.00mg), seedling vigour index- I (726)seedling vigour index- II (338), total dehydrogenase activity (1.947), total soluble seed protein (74.36µg/g) and α-amylase activity (79.84µmol/min) and lowest electrical conductivity (34.39 µS/cm) over their control followed by vermiwash, humic acid, cytozyme seed+ and VAM at 30% each. Hence, from the results it was concluded that compost tea at 30% can be used to enhance seedling quality of the sweet pepper seeds.

Keywords: Sweet pepper, bio-priming agents, vigour levels, seed enhancement

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the most important vegetable crop in world. Sweet pepper is grown world-wide because of its adaptation to different agroclimatic regions and its wide variety of shapes, sizes, colours and pungencies of the fruit [1]. Bell pepper or sweet pepper belongs to the genus *Capsicum*, a member of the Solanaceae family that includes other members such as chilli, tomato, potato and eggplant. Sweet pepper is a cultivar group of the species *Capsicum annuum* L. Cultivars of the plant produce fruits in different colours, including green, red, yellow and orange, but more exotic colours include purple, white and lime green. It is also known as bell pepper, capsicum and pepper. India produces an average of 563 thousand metric tonnes of capsicum annually from an area of 38 thousand hectares with a productivity of 14.82 MT per hectare accounting for one fourth of global production [2]. Sweet pepper is rich in ascorbic acid and good sources of vitamins A and B, 100 grams of fresh raw edible capsicum contain 93 per cent water, 20 kilo calories of energy, 4.64 grams of carbohydrates, 0.86 grams of protein, 1 to 2 grams of fibre, 0.17 grams of fat, 10 milligrams of calcium, 3 milligrams of sodium, 0.34 milligrams of iron, 20 milligrams of phosphorus, 80.4 milligrams of ascorbic acid and 0.057 milligrams of thiamine [3].

Modern agriculture with its bias for technology and precision, demands that each and every seed should readily germinate and produce a vigorous seedling ensuring higher yield. Seed enhancement techniques *viz.*, seed biopriming, seed polymer coating, seed coloring, seed pelleting, seed fortification, seed infusion, *etc.*, are being attempted and standardized for enhancing the planting value of seeds.

Bio-priming is a process of biological seed treatment that refers to combination of seed hydration (physiological aspect of invigoration) and inoculation (biological aspect of disease control) of seed with beneficial organism to protect seed. Seed treatments with biocontrol agents along with priming agents may serve as an important means of managing many of the soil and seedborne pathogens and diseases and improving nutrient use efficiency, the process often known as bio-priming. Bio-priming is a relatively new and emerging seed and/or seedling treatment tool that can be used to induce systemic resistance in treated crops against abiotic and biotic stresses [4]. Like other seed priming techniques, this technology has proven to be of paramount importance in improving seed quality and performance as well as in promoting plant growth.Seeds may be treated with microorganisms in a specific concentration for a specific duration or by coating with microbes.

MATERIAL AND METHODS

The research studies were carried out during 2022-23 in the laboratory of Department of Seed Science and Technology, University of Agricultural Sciences, Bengaluru. Three different vigour levels of Selection-3 sweet pepper were procured from ORBI Seed International Private Limited Bengaluru and used for the experiment. The seeds procured were dried to obtain uniform and safe level of seed moisture. Humic acid, vermiwash, compost tea from AICRP on Seed (Crops), UAS, GKVK, Bengaluruand cytozyme seed+, vesicular-arbuscular mycorrhiza (VAM) from ORBI Seed International Private Limited, Bengaluru were used in the present investigation.

Bio priming was conducted with different biopriming agents like humic acid, vermiwash, compost tea, cytozyme seed plus, VAM. The thirty percent solution was prepared by mixing 30 ml of biopriming agents in 70 ml of distilled water. Cleaned sweet pepper seeds of five gram was taken from each three seed lots were primed in a small glass beaker with the biopriming solutions for 16 h at 30°C. After the priming duration, the seeds were removed and then thoroughly rinsed for a two minute with distilled water. The primed seed were shade dried at room temperature until their original seed weight.

Further, three different seed lots of 85.0%, 80.0% and 71.0% as high, medium and low vigour seed lots, respectively were used for experiment. T_1: Control, T_2: Water Soaking, T_3: Humic acid at 30%, T_4: Vermiwash at 30%, T_5: Compost tea at 30%, T_6: Cytozyme seed plus at 30%, T_7: VAM at 30%.

Observations on various seed quality parameters *viz.*, seed germination (%), speed of germination [5], mean seedling length (cm), mean seedling dry weight (mg), seedling vigour index – I and II [6], electrical conductivity (µS/cm), total dehydrogenase activity[7], total soluble seed protein (µg/g), α-amylase activity (µmol/min)were recorded as per the methods and procedures described by ISTA[2]. The mean data of the laboratory experiments were statistically analyzed by adopting factorial completely randomized design. The critical differences were calculated at one per cent level of probability wherever 'F' test was found significant for various seed quality parameters under the study.

RESULTS AND DISCUSSION

Seed germination (%)

Among seeds of different vigour levels highest (86.0%) seed germination was recorded in high vigour seed lot (V_1), followed by 79.0% in medium vigour seed lot (V_2) and lowest (70.0%) was observed in low vigour seed lot (V_3). Among biopriming treatments, the highest (84.0%) seed germination was recorded in the seeds bio primed with compost tea at 30% (T_5) followed by 82.0% in the seeds bio primed with vermiwash at 30% (T_4) and 80.0% in seedsbio primed with humic acid at 30% (T_3). Whereas, seedsbio primed with VAM at 30% (T_7) recorded the lowest (75.0%) seed germination (Table 1).

Speed of germination

Among seed vigour levels, the highest (10.42) speed of germination was recorded in high vigour seed lot (V_1), followed by 8.81 in medium vigour seed lot (V_2) and lowest (7.84) was recorded in low vigour seed lot (V_3). Among biopriming treatments, the highest (10.25) speed of germination was observed in seeds bio primed with compost tea at 30% (T_5) followed by 9.64 in seeds bio primed with vermiwash at 30% (T_4) and 9.33 in seeds biopriming with humic acid at 30% (T_3), Whereas, seed priming with VAM at 30% (T_7) recorded the lowest (8.27) speed of germination (Table 1).

Priming seeds with compost tea had a better effect on seed germination. It is expected that water-soluble bioactive substances such as humic acids, phytohormones or other microbial metabolites present in vermicompost extract (compost tea) could be responsible for earlier emergence, increased seed germination percentage. In this experiment, germination percentage was increased when the seeds were soaked in vermicompost extract (compost tea) compared with seeds soaked in water. This suggests that factors beyond physical alteration of seed coats were responsible for earlier and better germination. Similar results were obtained by [8], who reported that germination percentage was enhanced by priming seeds in compost tea.

Table 1. Seed germination and speed of germination as influenced by bio priming treatments on different vigour levels in sweet pepper

Treatments(T)	Seed germination (%)				Speed of germination			
	Vigour levels (V)			Mean	Vigour levels (V)			Mean
	V_1	V_2	V_3		V_1	V_2	V_3	
T_1	81.0	73.0	65.0	73.0	8.76	8.11	7.07	7.98
T_2	85.0	80.0	69.0	78.0	10.13	8.99	8.32	9.15
T_3	87.0	81.0	73.0	80.0	11.06	9.00	7.92	9.33
T_4	88.0	82.0	77.0	82.0	11.61	9.10	8.20	9.64
T_5	90.0	83.0	78.0	84.0	12.74	9.55	8.47	10.25
T_6	84.0	77.0	67.0	76.0	9.60	8.53	7.48	8.54
T_7	83.0	75.0	66.0	75.0	9.03	8.39	7.40	8.27
Mean	86.0	79.0	71.0	79.0	10.42	8.81	7.84	9.02
	S.Em±	CD(0.01P)	CV (%)		S.Em±	CD(0.01P)	CV (%)	
V	0.34	0.98	2.00		0.11	0.31	3.58	
T	0.52	1.49			0.07	0.20		
V×T	0.90	2.58			0.19	0.53		

Note: Temperature: 30°C; Soaking duration:16 hours for priming treatment
Vigour levels: V_1: High vigour lot; V_2: Medium vigour lot ; V_3: Low vigour lot
Treatments:
T_1: Control
T_2: Hydropriming
T_3: Seed priming with humic acid at 30%
T_4:Seed priming with vermiwash at 30%
T_5: Seed priming with compost tea at 30%
T_6: Seed priming with cytozyme seed+ at 30%
T_7: Seed priming with *Vesicular-arbuscular mycorrhiza* (VAM) at 30%

Mean seedling length (cm)

Among seed vigour levels, the highest (8.52 cm) mean seedling length was recorded in high vigour seed lot (V_1), followed by 7.89 cm in medium vigour seed lot (V_2) and the lowest (7.31 cm) was observed in low vigour seed lot (V_3). Among biopriming treatments,the highest (8.65 cm) mean seedling length was recorded in the bio primed seeds with compost tea at 30% (T_5) followed by 8.39 cm in seeds bio primed with vermiwash at 30% (T_4) and 8.18 cm in seeds bi primed with humic acid at 30% (T_3), Whereas, seeds primed with VAM at 30% (T_7) showed the lowest (7.50 cm)mean seedling length (Table 2).

Mean seedling dry weight (mg)

Among seed vigour levels, the highest (4.00 mg) mean seedling dry weight was recorded in high vigour seed lot (V_1), followed by 3.30 mg in medium vigour seed lot (V_2) and lowest (3.10 mg) was observed in low vigour seed lot (V_3). Among biopriming treatments, the highest (4.00 mg) mean seedling dry weight was recorded in seeds bio primed with compost tea at 30% (T_5) followed by 3.60 mg in seeds bio primed with vermiwash at 30% (T_4) and 3.60 mg in seedsbio primed with humic acid at 30% (T_3), Whereas, seedsbio primed with VAM at 30% (T_7) recorded the lowest (3.10 mg) mean seedling dry weight (Table 2).

Priming seeds with compost tea had positive effect on seedling traits, which could be due to their ability to stimulate metabolic processes of growing seedlings, including enhanced cellular activities. Biopriming with vermicompost tea, which leads to a partial hydration of seeds modulation in pre-germinative metabolic activities influencing the development of seedling length and dry weight. Similar results with the report of [9] who found that seedling length and dry weight of lettuce varieties were increased by priming with vermicompost tea.

Seedling vigour index – I (SVI-I)

Among seed vigour levels, the highest (730) seedling vigour index - I was recorded in high vigour seed lot (V_1), followed by 624 in medium vigour seed lot (V_2) and lowest (517) was recorded in low vigour seed lot (V_3). Among bio priming treatments the highest (726) SVI – I was registered in the seeds primed with compost tea at 30% (T_5) followed by 693 in seeds primed with vermiwash at 30% (T_4) and 659 in seed priming with humic acid at

Table 2. Influence of different vigour levels and biopriming treatments on mean seedling length, mean seedling dry weight, seedling vigour index-I and seedling vigour index-II of sweet pepper

Treat-ments (T)	Mean seedling length (cm)				Mean seedling dry weight (mg)				SVI-I				SVI-II			
	Vigour levels (V)			Mean	Vigour levels (V)			Mean	Vigour levels (V)			Mean	Vigour levels (V)			Mean
	V_1	V_2	V_3		V_1	V_2	V_3		V_1	V_2	V_3		V_1	V_2	V_3	
T_1	7.95	6.99	6.43	7.12	3.28	2.82	2.73	2.90	647	512	420	526	267	207	178	217
T_2	8.44	7.64	7.44	7.84	3.98	3.26	3.07	3.40	717	611	510	613	338	261	211	270
T_3	8.62	8.40	7.52	8.18	4.06	3.44	3.15	3.60	747	683	546	659	352	280	229	287
T_4	8.86	8.74	7.59	8.39	4.43	3.26	3.26	3.60	782	716	582	693	392	267	250	303
T_5	9.17	8.91	7.87	8.65	4.69	3.95	3.38	4.00	825	740	613	726	422	328	263	338
T_6	8.38	7.41	7.26	7.68	3.85	3.05	2.98	3.30	703	568	483	585	323	234	199	252
T_7	8.25	7.18	7.07	7.50	3.57	2.99	2.80	3.10	688	536	464	563	298	223	184	235
Mean	8.52	7.89	7.31	7.91	4.00	3.30	3.10	3.40	730	624	517	624	342	257	215	272
	S.Em±	CD(0.01P)	CV (%)		S.Em±	CD(0.01P)	CV (%)		S.Em±	CD(0.01P)	CV (%)		S.Em±	CD(0.01P)	CV (%)	
V	0.06	0.16	3.3		0.02	0.07	3.28		4.8	13.72	3.52		2.25	6.43	3.79	
T	0.09	0.25			0.04	0.11			7.33	20.95			3.43	9.82		
V×T	0.15	0.43			0.06	0.19			12.7	36.29			5.95	17		

Note: Temperature: 30°C; Soaking duration:16 hours for priming treatment
Vigour levels: V_1: High vigour lot; V_2: Medium vigour lot ; V_3: Low vigour lot
Treatments:
T_1: Control
T_2: Hydropriming
T_3: Seed priming with humic acid at 30%
T_4:Seed priming with vermiwash at 30%
T_5: Seed priming with compost tea at 30%
T_6: Seed priming with cytozyme seed+ at 30%
T_7: Seed priming with *Vesicular-arbuscular mycorrhiza* (VAM) at 30%

30% (T_3), Whereas, seed priming with VAM at 30% (T_7) recorded the significantly lowest (563) SVI-I.

Seedling vigour index - II

Among seed vigour levels, the highest (342) seedling vigour index - II was recorded in high vigour seed lot (V_1), followed by 257 in medium vigour seed lot (V_2) and lowest (215) was showed in low vigour seed lot (V_3). Amongbiopriming treatments,the highest (338) SVI – II was recorded in seeds bio primed with compost tea at 30% (T_5) followed by 303 in seeds bio primed with vermiwash at 30% (T_4) and 287 in seedsbio primed with humic acid at 30% (T_3), Whereas, seeds primed with VAM at 30% (T_7) showed the significantly lowest (217).

Seedling vigour indices reflected the activity and performance of the seed during germination and if the seedling length and dry weight exhibit good result, the vigour indices also high [9].

Electrical conductivity of seed leachates (µS/cm)

Among seed vigour levels, the lowest (38.55 µS/cm) electrical conductivity was recorded in high vigour seed lot (V_1), followed by 45.85 µS/cm in medium vigour seed lot (V_2) and highest (59.65 µS/cm) was observed in low vigour seed lot (V_3). Amongbio priming treatments,the lowest (34.39 µS/cm) electrical conductivity was recorded in seeds bio primed with compost tea at 30% (T_5) followed by 39.91 µS/cm in seeds bio primed with vermiwash at 30% (T_4) and 42.12 µS/cm in seedsbio primed with humic acid at 30% (T_3). Whereas, seeds bio primed with VAM at 30% (T_7) observed the significantly highest (57.43 µS/cm) electrical conductivity.

Membrane integrity, as determined by electrical conductivity test, is closely related with seed vigour. In the present investigation, electrical conductivity of seed leachates was reduced with compost tea bio priming which indicates improvement in seed vigour. This is due to presence of some enzymatic metabolites and phytohormones which prevents damage to membrane and enhances seed germination.

Total dehydrogenase activity (TDH at A_{480})

The highest total dehydrogenase activity (1.795) was recorded in high vigour seed lot (V_1), followed by (1.582)

Table 3. Electrical conductivity, total dehydrogenase activity (TDH A_{480}), total soluble seed protein and amylase activity as influenced by different vigour levels and bio priming treatments on in sweet pepper

Treat-ments (T)	EC(μS/cm)				TDH (A_{480})				Total soluble seed protein (μg/g)				Amylase activity (μmol/min)			
	Vigour levels (V)			Mean	Vigour levels (V)			Mean	Vigour levels (V)			Mean	Vigour levels (V)			Mean
	V_1	V_2	V_3		V_1	V_2	V_3		V_1	V_2	V_3		V_1	V_2	V_3	
T_1	56.27	67.94	69.51	64.57	1.581	1.436	1.043	1.353	39.98	34.78	30.75	35.17	76.31	51.27	42.62	56.73
T_2	36.45	41.63	60.66	46.25	1.707	1.527	1.206	1.480	76.75	60.27	44.58	60.53	88.63	65.40	59.34	71.12
T_3	31.13	37.95	57.27	42.12	1.826	1.634	1.288	1.583	81.91	66.56	46.55	65.01	95.47	71.55	60.15	75.73
T_4	28.49	36.07	55.19	39.91	1.946	1.779	1.437	1.721	89.86	67.57	53.67	70.37	98.35	73.65	61.40	77.80
T_5	25.41	33.86	43.91	34.39	2.286	1.880	1.676	1.947	96.14	68.44	58.49	74.36	101.81	75.48	62.24	79.84
T_6	41.28	48.32	64.75	51.45	1.691	1.427	1.092	1.403	70.87	54.67	40.42	55.32	85.56	63.41	56.45	68.47
T_7	50.83	55.19	66.27	57.43	1.526	1.395	1.087	1.336	55.32	44.37	35.55	45.08	82.42	60.61	52.57	65.20
Mean	38.55	45.85	59.65	48.02	1.795	1.582	1.261	1.546	72.98	56.66	44.29	57.98	89.79	65.91	56.40	71.62
	S.Em±	CD(0.01P)		CV (%)	S.Em±	CD(0.01P)		CV (%)	S.Em±	CD(0.01P)		CV (%)	S.Em±	CD(0.01P)		CV (%)
V	0.39	1.11		3.71	0.01	0.03		3.50	0.64	1.83		3.31	0.75	2.14		3.18
T	0.59	1.70			0.02	0.05			0.42	1.20			0.49	1.40		
V×T	1.03	2.94			0.03	0.09			1.11	3.17			1.30	3.71		

Note: Temperature: 30°C; Soaking duration:16 hours for priming treatment

Vigour levels: V_1: High vigour lot; V_2: Medium vigour lot ; V_3: Low vigour lot

Treatments:

T_1: Control

T_2: Hydropriming

T_3: Seed priming with humic acid at 30%

T_4:Seed priming with vermiwash at 30%

T_5: Seed priming with compost tea at 30%

T_6: Seed priming with cytozyme seed+ at 30%

T_7: Seed priming with *Vesicular-arbuscular mycorrhiza* (VAM) at 30%

medium vigour seed lot (V_2) and lowest (1.261) was recorded in low vigour seed lot (V_3). Among biopriming treatments, the highest (1.947) total dehydrogenase activity was recorded when seeds bio primed with compost tea at 30% (T_5) followed by 1.721 in seeds bio primed with vermiwash at 30% (T_4) and 1.583 in seeds primed with humic acid at 30% (T_3), Whereas, seeds bio primed with VAM at 30% (T_7) showed significantly lowest (1.336) total dehydrogenase activity.

Increased TDH activity is an index of higher respiratory level that supports increased cellular biosynthetic activities. In the current study, increased TDH activity was observed when the seeds are primed with compost tea that might be associated with the combined effects of of humic acid substance and microbial metabolites which improves seed germination.

Total soluble seed proteins (μg/g)

Among seed vigour levels, the highest (72.98 μg/g) total soluble seed protein was recorded in high vigour seed lot (V_1), followed by 56.66 μg/g in medium vigour seed lot (V_2) and lowest (44.29 μg/g) was observed in low vigour seed lot (V_3). Among bio primingtreatments,the highest (74.36 μg/g) total soluble seed protein was recorded in seeds bio primed with compost tea at 30% (T_5) followed by 70.37 μg/g in seeds bio primed with vermiwash at 30% (T_4) and 65.01 μg/g in seedsbio primed with humic acid at 30% (T_3), Whereas, seed priming with VAM at 30% (T_7) showed the significantly lowest (45.08 μg/g)total soluble seed protein.

In the present investigation, enhanced total soluble seed protein content of sweet pepper seeds after treatment with compost tea might be attributed to presence of humic substances in the compost tea which stimulate nitrate metabolism and thereby influence seed protein content and the building of seed biomass. In a similar study, tomato seeds treated with vermicompost extract (compost tea) showed significant increases in the total protein content in the seedlings [10].

Amylase activity (μmol/min)

Highest (89.79 μmol/min) amylase activity was recorded in high vigour seed lot (V_1), followed by 65.91 μmol/min in medium vigour seed lot (V_2) and lowest (56.40 μmol/

min) was recorded in low vigour seed lot (V_3). Among bio priming treatments, the highest (79.84 µmol/min) amylase activity was recorded in seeds bio primed with compost tea at 30% (T_5) followed by 77.80 µmol/min in seeds bio primed with vermiwash at 30% (T_4) and 75.73 µmol/min in seeds bio primed with humic acid at 30% (T_3), Whereas, seeds bio primed with VAM at 30% (T_7) recorded significantly lower (65.20 µmol/min) amylase activity. Enhanced amylases in turn hydrolyse starch in the endosperm, providing the essential sugars for the germinating seeds and growing seedlings.

Thus, overall, bio priming of sweet pepper seeds with 30% compost tea exhibited higher seedling vigour as a result of the activation key metabolic processes.

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