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Influence of biopriming for enhancing seed yield and quality in *Sorghum* varieties (*Sorghum bicolor* L. Moench)

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Abstract
Sorghum is an important tropical cereal food, feed and fodder crop. It is important grain and forage crop of semiarid regions due to its high adaptability and suitability to rainfed low input agriculture. The present experiment consist of three varieties *viz*., SPV-2217, GS-23 and M 35-1 and nine treatments *viz*., T_0 - Hydro priming, T_1 - *Azospirillum brasilense* @ 20 %, T_2 - *Pseudomonas fluorescence* @ 20 %, T_3 - *Phosphobacteria* @ 20 %, T_4 - *Trichoderma harzianum* @ 1 %, T_5 - Beejamrutha @ 50 %, T_6 – Vermiwash @ 2 %, T_7 – Vihaan @ 5 %, T_8 - Waste decomposer @ 20 %. Seeds biopriming with *Pseudomonas fluorescence* @ 20 % in variety GS-23 (T_2V_2) recorded significantly higher germination (93.33 %), seedling length (38.90 cm), seedling dry weight (347.00 mg), test weight (34.30 g), seedling vigour index I (3630.70) and seedling vigour index II (32381.00) compared to other treatment in the experiment.

Keywords: Biopiming, vigour, quality

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench], a cultivated diploid (2n=20) tropical cereal C_4 grass plant is a fourth most important cereal crop grown in the world. It is a monocotyledon plant of tropical origin, belonging to Poaceae family. *Sorghum* is called as camel of crops due to its high tolerance to water and temperature stress and also high photosynthesis efficiency. It is considered as an important crop plant in arid and semi-arid regions (Anagholi *et al*., 2000) [2].
Sorghum is grown in India in an area about 4.09 mha with production of 3.48 m tonnes and productivity of 845 kg/ha (Anon. 2019) [3]. As a food grain, interest in *Sorghum* use in the developed world is growing due to dietary diversification trends like 'gluten-free' and 'ancient grains' (Awika, 2017) [4], as well as its increased recognition as a health promoting grain with unique bioactive compounds that contribute to reduced inflammation and adiposity, postprandial blood glucose response and other chronic conditions. Its regional importance is as much as that of wheat and rice.
Poor crop establishment is one of the major constraints reported by the farmers cultivating *Sorghum*. Rapid and uniform field emergence are two essential prerequisites to increase yield and quality of seeds in crops. Uniformity and increased seedling emergence of direct-seeded crops have a major impact on final yield and quality (Gupta *et al*., 2008) [6].
Seed priming is a pre-sowing seed treatment that involves the controlled hydration of seeds, sufficient to allow pre-germinative metabolic events to take place but radical emergence does not occur (Heydecker, 1975) [8]. Priming allows the metabolic processes necessary for germination without protrusion of radicle. Priming accelerates germination and emergence (Taylor *et al*, 1998) [19].
Bio priming is a good treatment system that integrates the biological and physiological aspects of enhancing growth, disease control and increase in yield, which involves coating the seed with biological agents and incubating the seed under warm and moist conditions. Excessive and continuous use of chemical fertilizers coupled with pesticides and fungicides have damaged the cultivation and productivity. Now a days the chemical fertilizers are replaced by environment friendly bio-fertilizers. Most of the bio-fertilizers manufactured in India are solid carrier based and generally suffer from shorter shelf life, poor quality, high contamination and low field performance (Hegde, 2002) [7].
Priming with PGPR increase germination and improve seedling establishment. It the physiological process of germination, but prevents the emergence of plumule and radicle.

The initiation of the physiological process helps in the establishment and proliferation of PGPR on the spermosphere (Taylor and Harman, 1990) [18].

Pseudomonas fluorescence primed seeds shows enhancement in the germination percentage, seedling growth mainly due to the production of plant growth regulators such as gibberellins, cytokinins, and indole acetic acid and it also makes increased availability of minerals and other ions (Sridevi and Manonmani, 2016) [17].

Materials and Methods

The laboratory experiment were conducted at Department of Seed Science and Technology, College of Agriculture, Raichur during *rabi* 2019-2020. The experiment was carried out in factorial complete randomized design (FCRD). The present study aimed to study the Influence of seed biopriming in *Sorghum* varieties to improve quality of seeds. Seeds were soaked for twelve hours with biopriming agents such as *Azospirillum brasilense*, *Pseudomonas fluorescence*, *Phosphobacteria*, *Trichoderma harzianum*, Beejamrutha, Vermiwash, Vihaan and Waste decomposer with the seed to solution ratio (w/v) of 1:1 under ambient conditions.

Treatment details

Factor-I: Treatments (T)

T_o - Hydro priming
T_1 - *Azospirillum brasilense* @ 20 %
T_2 - *Pseudomonas fluorescence* @ 20 %
T_3 - *Phosphobacteria* @ 20 %
T_4 - *Trichoderma harzianum* @ 1 %
T_5 - Beejamrutha @ 50 %
T_6 – Vermiwash @ 2 %
T_7 - Vihaan @ 5 %
T_8 - Waste decomposer @ 20 %

Factor-II Varieties (V)

V_1 - SPV-2217
V_2 - GS-23
V_3- M 35-1

Results and Discussion

In the current investigation, *Sorghum* seeds bioprimed with *Pseudomonas fluorescence* @ 20 % (T_2) recorded significantly higher germination per cent (91.44 %), seedling length (36.92 cm), seedling dry weight (307.33 mg), test weight (31.89 g) seedling vigour index I and II (3379 and 28174), While, lower was recorded in Hydro priming treatment (T_0) (82.00 %, 26.05 cm, 163.66 mg, 29.36 g, 2137 and 13429, respectively).

All the seed quality parameters differed significantly between the varieties. The variety GS-23 (V_2) recorded significantly higher germination (89.37 %), seedling length (33.52 cm), seedling dry weight (282.55 mg), test weight (32.97 g) seedling vigour index I and II (3055 and 25390). While, lower was recorded in variety M 35-1 (85.18 %, 29.76 cm, 207.11 mg, 28.29 g, 2543 and 17705 respectively).

Among the interactions between varieties and different seed biopriming treatments differed significantly for seed quality parameters. Seeds bio primed with *Pseudomonas fluorescence* @ 20 % in variety GS-23 (T_2V_2) recorded higher seed germination (93.33 %), seedling length (38.90 cm), seedling dry weight (347.00 mg), test weight (34.30 g), seedling vigour index I and II (3631 and 32381). While, lower germination per cent (81.33 %), seedling length (23.90 cm), seedling dry weight (149.00 mg), test weight (26.80 g), seedling vigour index I and II (1944 and 12143) recorded in treatment Hydro priming in variety M 35-1.

The highest germination percent recorded in the present study might be due to the fact that the primed seed with *Pseudomonas fluorescence* 20 per cent showed increase in the seed metabolic efficiency when compared to nonprimed seeds. The higher metabolic efficiency leading to mobilization of reserve food to the embryo for early initiation of germination as reported by Wellman, 1961 [21] in coffee and Job *et al*., 2000 [9] in sugar beet.

The higher seedling length (cm) in seeds primed might be attributed to enlarged embryos, higher rate of metabolic activities and respiration, better utilization and mobilization of metabolites to growing points and higher activity of enzymes. The results colloborates with the findings of Ramamoorthy *et al*. (1989) [15] in maize.

The metabolites release certain enzymes responsible for degradation of macromolecules into micro molecules within the seed responsible for the higher growth of seedling increased the dry weight. Similar results are also reported by Kumar and Uppar (2007) [11] in moth bean.

Table 1: Influence of seed biopriming treatments on seed germination, seedling length and Seedling dry weight in *Sorghum* varieties

Treatments	Germination (%)				Seedling length (cm)				Seedling dry weight (mg)			
	SPV-2217	GS-23	M 35-1	Mean	SPV-2217	GS-23	M 35-1	Mean	SPV-2217	GS-23	M 35-1	Mean
T_o-Hydro priming	82.00	82.66	81.33	82.00	26.40	27.86	23.90	26.05	162.00	180.00	149.00	163.66
T_1-*Azospirillum brasilense* @ 20%	90.00	91.33	86.33	89.22	34.30	35.94	31.87	34.03	289.00	318.00	226.00	277.66
T_2- *Pseudomonas fluorescence* @ 20%	92.33	93.33	88.66	91.44	37.00	38.90	34.87	36.92	325.00	347.00	250.00	307.33
T_3- *Phosphobacteria* @ 20%	90.00	90.33	85.66	88.66	33.53	35.20	31.00	33.24	270.00	307.00	222.00	266.33
T_4-*Trichoderma harzianum* @ 1%	91.00	92.00	87.66	90.22	35.47	37.40	33.14	35.33	311.00	329.00	240.00	293.33
T_5-Beejamrutha @ 50%	87.66	89.33	85.00	87.33	31.10	31.90	28.93	30.64	230.00	275.00	205.00	236.66
T_6- Vermiwash @ 2%	89.33	89.66	85.33	88.11	32.90	34.04	30.03	32.32	256.00	296.00	215.00	255.66
T_7- Vihaan @ 5%	86.66	88.33	83.66	86.22	30.00	30.77	27.53	29.43	213.00	255.00	191.00	219.66
T_8-Waste decomposer @ 20%	86.00	87.33	83.00	85.44	28.10	29.67	26.64	28.13	190.00	236.00	166.00	197.33
Mean	88.33	89.37	85.18		32.08	33.52	29.76		249.56	282.55	207.11	
	SEM±	**CD (5)**			**SEM±**	**CD (5)**			**SEM±**	**CD (5%)**		
V	0.154	0.438			0.034	0.098			2.343	6.667		
T	0.267	0.759			0.060	0.170			4.057	11.547		
V×T	0.463	1.315			0.103	0.294			7.028	20.000		

Table 2: Influence of seed biopriming on Test weight, Seedling vigour index I and Seedling vigour index II in *Sorghum* varieties

Treatments	Test weight (g)				Seedling vigour index I				Seedling vigour index II			
	SPV-2217	GS-23	M 35-1	Mean	SPV-2217	GS-23	M 35-1	Mean	SPV-2217	GS-23	M 35-1	Mean
T_0-Hydro priming	29.60	31.70	26.80	29.36	2165	2304	1944	2137	13291	14853	12143	13429
T_1-*Azospirillum brasilense* @ 20%	31.20	33.40	28.97	31.19	3087	3282	2751	3040	25999	29034	19509	24848
T_2- *Pseudomonas fluorescence* @ 20%	32.00	34.30	29.37	31.89	3416	3631	3092	3379	30007	32381	22136	28174
T_3- *Phosphobacteria* @ 20%	31.00	33.20	28.60	30.93	3018	3180	2656	2951	24326	27762	18993	23694
T_4-*Trichoderma harzianum* @ 1%	31.50	33.80	29.10	31.46	3227	3441	2905	3191	28311	30245	21042	26532
T_5-Beejamrutha @ 50%	30.30	32.70	28.10	30.36	2726	2850	2459	2679	20156	24563	17397	20705
T_6- Vermiwash @ 2%	30.80	32.90	28.50	30.73	2939	3052	2563	2851	22888	26536	18345	22590
T_7- Vihaan @ 5%	30.09	32.50	27.80	30.13	2600	2718	2304	2540	18455	22530	15979	18988
T_8-Waste decomposer @ 20%	29.80	32.30	27.40	29.83	2417	2591	2211	2406	16371	20609	13805	16929
Mean	30.70	32.97	28.29		2844	3005	2543		22200	25390	17705	
	SEM±	**CD (1%)**			**SEM±**	**CD (5%)**			**SEM±**	**CD (5%)**		
V	0.029	0.081			6.515	18.523			233.340	663.425		
T	0.050	0.141			11.284	32.083			404.157	1149.086		
V×T	0.086	0.244			19.545	55.570			700.021	1990.275		

The beneficial effects of *Pseudomonas fluorescence* 20 per cent priming on seedling vigour expressed in this study might be the result of a synergism of priming effect with bacterial effect, since priming confers benefits such as completion of early germination phases, increasing the population of bioprotectants, rapid and uniform seedling emergence, facilitation of uptake of water and nutrients, protection against pathogens, potential defense responses such as early oxidation burst, incorporation of various phenolic compounds and polymers to the cell wall and secretion of phytoalexins (Musa *et al*., 1999 [13] in chickpea and Conrath *et al*., 2002 [5] in arabidopsis.

The highest germination percent (%), seedling length (cm), seedling dry weight (g), test weight (g), seedling vigour index I and Seeding vigour index II was recorded in variety GS-23 compared to other varieties. This variance may be due to differential genetic makeup of varieties. These results are in similar line with those Amarnath *et al.* (2015) [1], Mohammed *et al.* (2018) [12], Pinheiro *et al.* (2018) [14], Teshome *et al.* (2018) [20], Kale *et al.* (2019) [19], Shihab and Hamza (2019) [16] in *Sorghum.*

Conclusion

Among the different priming treatment *Sorghum* seeds primed with *Pseudomonas fluorescence* @ 20 per cent in variety GS-23 for 12 h showed better seed quality parameters *viz*., germination, seedling length, seedling dry weight, Test weight and seedling vigour index I and II compared to other treatments.

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