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Effect of Seed Biopriming on Growth, Yield and Economics of *Rabi* Green Gram (*Vigna radiata* L.) in Rainfed Condition of Balasore District of Odisha

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ABSTRACT

Background: Green gram [*Vigna radiata* (L.) Wilczek] is the 3rd major pulse crop of India but low yield in green gram largely due to the use of poor quality seed in rainfed condition, inadequate crop management and cultivation in inhospitable soils. Seed priming with biofertilizers recorded better germination, crop growth and seed yield in pulse crops. The present trial was conducted to study the efficacy of seed treatment with different biofertilizers on growth and yield of green gram.

Methods: The present study was conducted by Krishi Vigyan Kendra, Balasore (OUAT) at Ganja and Basulidiga village of Basta block of Balasore district during *Rabi* 2021 and 2022. The trial was carried out through randomized block design consisting of four treatments *viz.* T_1: Farmer practice (hydro priming); T_2: Biopriming with liquid *Rhizobium* 5%; T_3: Biopriming with liquid PSB 5% and T_4: Biopriming with *Pseudomonas* 5% replicated seven times. Growth attributes, yield components, yield and economics were studied.

Result: The results of the trial revealed that, biopriming with liquid *Rhizobium* 5% produced the highest plant height, number of nodule per plant and seed yield values during the year 2021 and 2022 than biopriming with PSB, *Pseudomonas* and control. The Study helps to improve the seed quality with the help of seed priming treatments which is cost effective for the farmer.

Key words: Biopriming, Economics, Green gram, PSB, *Rhizobium*, Seed yield.

INTRODUCTION

Green gram [*Vigna radiata* (L.) Wilczek] is also popular as mungbean, golden gram, mung or moong. It is the 3rd most important pulse crop of India and cultivated in an area of 40.38 lakh ha with 31.5 lakh tonnes production, an average productivity of 783 kg ha^{-1} and contributes 11 % to the total pulse production for 2021-22. Major components of green gram were protein (20-24%), carbohydrate (60-62%) and fiber (4.0%). The protein found in moong is rich in lysine but deficient in cysteine and methionine. This mineral and protein rich crop plays vital role in biological nitrogen fixation in the soil (Kannaiyan, 1999).

Green gram is cultivated in 6,51,420 ha during Rabi season with production of 326.36 metric tonnes in Odisha. In Balasore district, around 13000 ha is covered with Rabi green gram with productivity of 498 kg ha^{-1}which is lower than state average of 501 kg ha^{-1} during the same periodas published by Directorate of Agriculture and Food Production, Govt. of Odisha, 2018-19.

The lack of successful germination and establishment of green gram was largely due to the use of seeds of poor quality, sowing in a rain-fed condition, reduced plant stand, inadequate crop management and cultivation in inhospitable soils (Sathiya *et al*., 2017). High crop yield can be obtained through better germination of seed and improved seedling characteristic but crop loss with reduced income may be due to poor germination and impoverished seedling growth (Ghiyasi *et al*., 2008).

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Seed priming exposes seeds to low water potentials through controlled hydration process thereby restricting germination but permits changes to pre-germinative physiological and biochemical parameters (Khan, 1992). Seed priming with liquid formulations of biofertilizers resulted in improving seed germination, plant growth and seed yield of leguminous crops Gomathy *et al*. (2007) and Kaur *et al.* (2006). The treatment of seeds with *Rhizobium* has found to be effective in promoting nodulation capacity and nitrogenase activity (Rahmianna *et al*., 2000) in many crops.

Keeping in view the significance of bio-priming approach, we have conducted this field study during 2021 and 2022 to examine the outcome of seed bio-priming on germination, growth and yield of green gram.

MATERIALS AND METHODS

An on farm trial was conducted by Krishi Vigyan Kendra, Balasore (OUAT) in green gram crop at Ganja and Basulidiga village under Basta during Rabi 2021 and 2022, respectively. The geographical location of the area has 87°17′ to 87°21′E longitude and 21°61′ to 21°65′N latitude and average elevation of 195 m above mean sea level. 428.2 mm and 256.6 mm rainfall received during the crop season (January to April) for 2021 and 2022, respectively. The temperature data collected during 2021 ranges from 17.5°C to 33.9°C and 19.8°C to 37.5°C during 2022. The soil tested from trial plot revealed to be acidic (pH 5.7 and 5.2), clay loam and sandy clay loam in texture with medium organic carbon content (0.65 and 0.57%), medium in nitrogen (289.4 and 275.3 kg ha^{-1}), phosphorus (18.8 and 16.7kg ha^{-1}) and potassium (183.2 and 178.8 kg ha^{-1}) content in Ganja and Basulidiga, respectively. The trial was carried out through randomized block (RBD) design consisting of four treatments *viz*. T_1: Farmer practice (hydro priming); T_2: seed biopriming with liquid *Rhizobium* 5%; T_3: seed biopriming with liquid phosphorus solubilizing bacteria (PSB) 5% and T_4: seed biopriming with *Pseudomonas* 5% by replicating seven times. Fresh seeds of green gram var. IPM-02-14 having the initial germination of 80 per cent were subjected to priming per the above treatment details. Seeds were soaked in double the volume of solutions for 1 h followed by slow moistening in gunny bag for 2 h. Hydro priming was also attempted and served as control. Green gram crop seeds were sown in 0.1 acre plot during 4th week of January and harvested during 2nd week of April. The recommended fertilizer dose of 20-40-40 kg N-P_2O_5-K_2O/ha was applied with a single spraying of NPK (18:18:18) @ 2% at vegetative stage. Standard agronomic practices were followed for cultivating the crop. Findings on different parameters like days to germination, growth and yield attributes were recorded and economic analysis was done. Three pickings were done and the final crop yield was recorded. The gross return was calculated on the basis of prevailing market price of the produce. Net return and benefit-cost ratio was calculated using the following formula:

$$\text{Net return} = \text{Gross return (ha}^{-1}\text{)} - \text{Cost of cultivation (ha}^{-1}\text{)}$$

$$\text{Benefit cost ratio} = \frac{\text{Gross return (ha}^{-1}\text{)}}{\text{Cost of cultivation (ha}^{-1}\text{)}} \times 100$$

Statistical analysis of the recorded data was conducted by using the online computer program 'OPSTAT' developed by Sheoran *et al*. (1998). The results are presented at 5% level of significance (p = 0.05).

RESULTS AND DISCUSSION

Seed priming can activate metabolic changes through physiological invigoration required for germination and reserve food materials mobilization. Better germination and uniform crop growth can be obtained through protein synthesis using sugars during germination (Rouhi *et al*., 2011).

Plant height is an important factor in providing more places for flower production leading to better pod and fruit yield. Seed biopriming treatments significantly influenced the plant height and number of branches per plant (Table 1). Biopriming with liquid *Rhizobium* 5% recorded the maximum plant height of 54.0cm which are significantly higher than biopriming with Pseudomonas and hydro priming during both the year. Higher number of branches per plant is also recorded from T_2 which is statistically at par with T_3 which is higher than that of control. The priming process increased the availability of both macro and

Table 1: Effect of biopriming treatments on growth parameters of green gram.

Treatment	Plant height (cm)			No. of branches plant^{-1}			Days to germination		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1: Hydropriming	43.9	43.2	43.5	4.6	4.7	4.6	6.7	6.9	6.8
T_2: Biopriming with liquid *Rhizobium* 5%	53.3	54.7	54.0	5.1	5.3	5.2	5	4.6	4.8
T_3: Biopriming with liquid PSB 5%	50.1	51.1	50.6	4.9	5.1	5.0	5.9	5.5	5.7
T_4: Biopriming with *Pseudomonas* 5%	46.7	47.3	47.0	4.7	4.8	4.8	6.1	6.2	6.2
SEm±	0.16	0.34	0.516	0.06	0.05	0.025	0.27	0.18	0.394
C.D. at 5%	0.47	1.04	1.043	0.19	0.15	0.229	0.83	0.56	0.912

Table 2: Effect of biopriming treatments on yield attributes in green gram.

Treatment	Days to 50% flowering			No. of nodules plant^{-1}			No. of pods plant^{-1}		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1: Hydropriming	38.1	38.4	38.3	6.3	6.6	6.4	13.1	13.7	13.4
T_2: Biopriming with liquid *Rhizobium* 5%	33.1	33.3	33.2	10.3	10.9	10.6	21.7	21.9	21.8
T_3: Biopriming with liquid PSB 5%	35.4	34.6	35.0	9.3	9.7	9.5	19.3	19.9	19.6
T_4: Biopriming with *Pseudomonas* 5%	37.0	37.7	37.3	7.1	7.6	7.4	16.3	16.6	16.4
SEm±	0.24	0.22	0.378	0.48	0.41	1.042	0.48	0.41	1.419
C.D. at 5%	0.72	0.66	0.893	1.44	1.24	1.482	1.44	1.24	1.729

micronutrients throughout the growing season. This may have contributed to the increased translocation of nutrients into the plant without any loss, which in turn contributed to improved photosynthesis and resulted in a significant rise in plant height and branches per plant as corroborated by (Elankavi *et al*., 2019 and Kavitha *et al*., 2020). Increased supply of nutrients during initial stages may also due to more nodulation by *Rhizobium* and rhizosphere effect through microbial activity modifies the plant itself by providing the plant growth and increasing the availability of elements to the root zone (Adhithya *et al*., 2023). Also increase in plant height of 50.6cm is recorded in biopriming with liquid PSB 5% (T_3) which is higher than the control (T_1). The seed priming with PSB increased the availability of soluble phosphorus thereby improving plant growth and resulted in more plant height. Similar results were recorded by Shaktawat and Sharma (2001). Conversion of phosphorus to available forms during vegetative growth stage due to PSB inoculation would have helped absorption of all major and minor nutrients required for improving in the number of branches per plant which is also recorded by Naik and Rajput (2003). Number of nodules per plant differed significantly among seed biopriming treatments.

The treatment biopriming with liquid *Rhizobium* 5% (T_2) recorded highest number of nodules (10.6) followed by T_3 (9.5) and T_4 (7.4) while lowest was recorded in control (6.4) (Table 2). Seed priming with *Rhizobium* recorded more number of nodules at all the growth stages. A high population of rhizobia before sowing is required to ensure the survival on seed and in the soil to bring about effective nodulation which also reported in pulses by Prakash *et al*. (2012).

During both the years of study, it was observed that *Rhizobium* and PSB bio primed seed germinate faster than that of Pseudomonas and hydro priming. Rhizobium and PSB bio primed seed taken 4.8 and 5.7 days for initial germination respectively which is significantly faster than Pseudomonas (6.2 days) and hydro priming (6.8 days) (Table 1). Higher rate of germination of primed seeds primarily happens because of reduction in the lag time of imbibitions, enzymatic activation, accumulation of germination enhancing metabolites and metabolic repair during imbibitions and osmotic adjustment (Hussain *et al*., 2015). Also flowering in hydro primed seed (T_1) was delayed by 4-5 days than other treatments which may be due to late germination which hampers growth and subsequent flowering as observed by Dragicevic *et al*. (2013).

Statistically significant difference is recorded between treatments for yield attributes number of pods per plant, number of seeds per pod and 100 seed weight. Biopriming with liquid *Rhizobium* resulted in 21.8 pods per plant which was 11.2, 32.9 and 62.6% significantly higher than that of T_3, T_4 and control, respectively (Table 2). Due to early germination and good vegetative growth, higher number of seed plant (7.7) was recorded in the *Rhizobium* seed treatment followed by PSB and *Pseudomonas* biopriming.

Table 3: Effect of biopriming treatments on yield attributes and yield in green gram.

Treatment	No. of seed pod^{-1}			100 seed weight (g)			Seed yield (q ha^{-1})			Stover yield (q ha^{-1})		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1: Hydropriming	4.7	5.0	4.8	3.0	3.2	3.1	6.2	6.2	6.2	25.8	26.9	26.3
T_2: Biopriming with liquid *Rhizobium* 5%	7.6	7.9	7.7	4.7	4.8	4.8	8.1	7.3	7.7	29.9	29.8	29.8
T_3: Biopriming with liquid PSB 5%	6.8	6.9	6.9	4.0	4.2	4.1	7.8	7.1	7.4	29.2	29.2	29.2
T_4: Biopriming with *Pseudomonas* 5%	5.6	6.0	5.8	3.6	3.8	3.7	7.6	6.8	7.2	28.6	28.4	28.5
SEm±	0.07	0.08	0.047	0.05	0.07	0.28	0.09	0.05	0.39	0.82	0.62	2.72
C.D. at 5%	0.22	0.26	0.315	0.16	0.21	0.244	0.27	0.15	0.285	2.47	1.86	2.396

Table 4: Effect of biopriming treatments on economics of green gram.

Treatments	Cost of cultivation (× 10^3 ` ha^{-1})			Gross return (× 10^3 ` ha^{-1})			Net return (× 10^3 ` ha^{-1})			B:C ratio		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1: Hydropriming	23250	20000	21625	37114	37200	37157	13864	17200	15532	1.60	1.86	1.73
T_2: Biopriming with liquid *Rhizobium* 5%	23875	20675	22275	48686	44057	46371	24811	23382	24096	2.04	2.13	2.09
T_3: Biopriming with liquid PSB 5%	23875	20675	22275	46629	42343	44486	22754	21668	22211	1.95	2.05	2.00
T_4: Biopriming with *Pseudomonas* 5%	24125	20875	22500	45343	40543	42943	21218	19668	20443	1.88	1.94	1.91
SEm±	112.58	61.76		543.79	317.19		507.26	322.87		0.02	0.01	
C.D. at 5%	337.10	184.92		1628.21	949.73		1518.84	966.74		0.06	0.04	

Lower number of seeds per pod (4.8) is recorded in the hydro primed seed. *Rhizobium* contributes to nitrogen fixation and PSB helps in phosphorus mobilization which is essential for nodulation and contributed to more fixing of atmospheric nitrogen which enhances photosynthesis, pod development and eventually more number of pods per plant (Gupta *et al*., 2006).

Seed yield was significantly influenced by the treatment during both the years (Table 3). Biopriming with liquid *Rhizobium* 5% recorded the maximum seed yield (7.7 q ha^{-1}) followed by liquid PSB 5% (7.4q ha^{-1}) accounting 19.5% increase over the existing farmer's practice, which is at par with the biopriming with *Pseudomonas* during 2021. The increase in seed yield of green gram resulted from increasing the number of branches per plant, more number of pods per plant and more number of seeds per plant subsequently increased the seed yield as corroborated by Biswas and Bhowmick (2007) and Bhuiyan *et al*. (2006). The analysed data revealed that biopriming with *Rhizobium* and PSB significantly increased the biological yield than hydro priming. The highest biological yield recorded in T2 (29.8 qha^{-1}) followed by T3 (29.2 qha^{-1}) while the lowest biological yield recorded in control (26.3 qha^{-1}). Higher biological yield may be due to may be due to increased availability of N and P in soil for better plant uptake and their growth promoting activities which is corroborated by Paul *et al*. (2023).

The cost of cultivation has not significantly been influenced by seed biopriming treatments as observed in Table 4. Cost of cultivation of the treatment T_4 during both the year is higher than that of both biopriming with liquid *Rhizobium* and liquid PSB due to higher market cost of *Pseudomonas*. Biopriming with liquid *Rhizobium* followed by liquid PSB recorded the maximum gross and net return of 46,371 and 24,096 ` $ha^{-1}$ during the trial which are statistically significant than the control. Minimum gross and net return of 37,517 and 15,532 ` ha^{-1} is observed from the farmers practice (hydro priming).

CONCLUSION

Bio-fertilisers are micro organisms that can be engineered to contain living nitrogen-fixing and phosphate-soluble microorganisms for the purpose of fertilizing seed or soil. The *Rhizobium* and PSB bio primed seeds germinate earlier than that of hydro priming which will be helpful better plant stand-in rain-fed condition. Bio-primed seeds showed significantly higher seed and biological yield as compared to other treatments. Hence, farmers can benefit from the use of *Rhizobium* and phosphorus solubilizing bacteria, in combination with the recommended dosage of fertilizers, for green gram crop in order to increase yield and net return along with enhancing soil fertility.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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