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Effect of Biopelleting on Seed Yield of Soybean

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ABSTRACT: The field experiment was conducted to study the influence of biopelleting on seed yield and quality of soybean at the Water and Land Use Management Institute (WALMI) Farm, Dharwad. The fresh seeds of soybean were first pelleted with biofertilizers like *RhizobiumSb-120* (@ 25g kg^{-1} and 50g kg^{-1}) and *Pseudomonas striata* (@ 25g kg^{-1} and 50g kg^{-1}) and control (unpelleted) along with maida (Starch gruel @ 60ml kg^{-1}) as a binding material, shade dried and directly used for sowing. Among the seed pelleting with biofertilizers the seeds pelleted with *Rhizobium* Sb-120 @ 50 g + *Pseudomonas striata* @ 50g kg^{-1} seed has recorded highest field emergence (88%), plant height (64.88 cm), number of branches per plant (5.73), number of trifoliate leaves (24.70), less number of days to 50% flowering (38.33), over the unpelleted control seeds (81.33%, 56.87 cm, 4.23, 19.13 and 41.67 days, respectively). Higher seed yield of 21.41 q ha^{-1} with a 15.98 % increase in case of seed pelleted with *Rhizobium Sb-120* @ 50 g + *Pseudomonas striata* @ 50g kg^{-1} seed over control. Similarly, maximum number of pods per plant (95.27), pod length (3.69cm), number of seeds per pod (2.91), pod weight per plant (0.338g) and hundred seed weight (13.83g) was registered in seed pelleted with *Rhizobium Sb-120* @ 50g kg^{-1} + *Pseudomonas striata* @ 50g kg^{-1} seed over control (71.40, 2.97, 2.57, 0.253g and 12.54g). Biopelleting treatments improved the growth of plant either alone or in combination during early stage of crop with vigorous and stronger root system enabling plants to derive the available soil moisture and nutrients which resulted in enhanced growth and seed yield.

Keywords: Soybean, Pelleting, Biofertilizers, Rhizobium, *Pseudomonas striata*

Soybean {*Glycine max* (L.) Merrill} is known as Chinese pea or Manchurian bean believed to have originated in Northeastern China and distributed in Asia, USA, Brazil, Argentina etc. Soybean seeds provide 20 per cent of cholesterol free oil and 40 per cent of quality protein.It is a rich source of lysine (6.4%) in addition to other essential amino acids, vitamins *viz*., A, B, D and minerals. One of the major problems encountered in soybean production in India is lack of availability of quality seeds at the time of planting as many of the seed lots produced will lose their viability due to improper handling during post-harvest operations. The quality seed production and safe storage are the two main facets of successful seed production in soybean until next planting season. Biopelleting provides the advantage in reducing the post-harvest damage and helps in improving the seed quality. Biopelleting improves the chances of successful germination and seedling establishment under field condition and protect the seeds from seed borne fungal and insect attack finally contributing to increased seed yield. The performance of pelleted seeds is influenced by several factors *viz.*, seed coating material, soil and aerial environment and further physical, chemical and biological components. Biofertilizer pelleting is inexpensive and eco-friendly and has profound effect on seed quality. Application of beneficial microorganisms to seed for use in agriculture has been under intensive investigation for many years [1]. Microorganisms can be applied to perform specific functions, notably nitrogen fixation, phosphate solubilization, potassium mobilizing and stimulating plant growth through the synthesis of growth-promoting substances, which produce hormones, anti-metabolites and promote root growth. When applied to seed or soil, biofertilizers increase the availability of nutrients and improve the yields by 10 to 25 per cent without adverse effect on soil and environment, promote good plant health.

Biopelleting especially strains of *Rhizobium* + Phosphobacteria have potential to increase the productivity of crops. The increased germination of seeds pelleted with biofertilizers might be due to the increased cytokinin production which actively involved in cell division [2] and production of growth regulating

substances like auxin, GA_3 and cytokinin [3]. Thus, the pelleting of seeds with biofertilizers helps in healthy, vigorous and uniform field stand establishment in the field of time without affecting the quality. Hence, the study was conducted to know the best biopelleting treatment to enhance seed yield in soybean.

MATERIALS AND METHODS

The fresh seeds of soybean were first pelleted with biofertilizers like *RhizobiumSb-120* @ 25g/kg and 50g/kg of seed and *Pseudomonas striata* @ 25g/kg and 50 g/kg of seed individual and dual combinations and control (unpelleted) along with *maida* (Starch gruel @ 65 ml/kg) as a binding material, shade dried and directly used for sowing with nine treatment combinations and three replications in RCBD design.

Treatment details

B_1: Control

B_2: *Rhizobium* Sb-120 @ 25g/kg of seed

B_3: *Rhizobium* Sb-120 @ 50g/kg of seed

B_4: *Pseudomonas striata* @ 25g/kg of seed

B_5: *Pseudomonas striata* @ 50g/kg of seed

B_6: *Rhizobium* Sb-120 @ 25g/kg of seed + *Pseudomonas striata* @ 25g/kg of seed

B_7: *Rhizobium* Sb-120 @ 25g/kg of seed+ *Pseudomonas striata*@ 50g/kg of seed

B_8: *Rhizobium* Sb-120 @ 50g/kg of seed + *Pseudomonas striata* @ 25g/kg of seed

B_9: *Rhizobium* Sb-120 @ 50g/kg of seed + *Pseudomonas striata* @ 50g/kg of seed

The field experiment was conducted at Water and Land Use Management Institute (WALMI) Farm, Dharwad. The observations on growth and yield parameters were recorded and data were statistically analyzed by using randomized complete block design. The critical differences were calculated at 5 per cent level of probability wherever 'F' test was found significant.

RESULTS AND DISCUSSION

At the beginning significantly higher field emergence (Table 1) was noticed in seeds treated with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed (88%) which was on par with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed (87%) and *Rhizobium* Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed (86%) and *Rhizobium* Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed (86%), followed by *Rhizobium* Sb-120 @ 50g kg^{-1} of seed (85%) treated seeds. Seeds pelleted with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed recorded highest plant height number of branches and number of trifoliate leaves in all at 30 (19.97 cm, 3.17

Table 1. Effect of bio-pelleting on field emergence, plant height, and number of branches in soybean

Treatments	Field emergence	Plant height (cm)			Number of branches per plant		
	(%)	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS
Control	81(64.40)*	19.27	49.60	56.87	2.47	3.47	4.23
Rhizobium Sb-120 @ 25g kg^{-1} of seed	84(66.66)	19.40	52.87	58.91	2.60	3.80	4.50
Rhizobium Sb-120 @ 50g kg^{-1} of seed	85(67.46)	19.47	54.70	61.73	2.90	4.20	4.73
Pseudomonas striata @ 25g kg^{-1} of seed	83(65.89)	19.33	51.73	58.13	2.50	3.73	4.33
Pseudomonas striata @ 50g kg^{-1} of seed	85(67.19)	19.37	53.27	60.57	2.97	3.97	4.63
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	86(68.01)	19.50	55.22	62.17	3.00	4.27	5.07
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	86(68.28)	19.53	55.40	62.80	3.10	4.33	5.23
Rhizobium Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	87(68.85)	19.53	55.88	63.47	3.10	4.60	5.43
Rhizobium Sb-120 @ 50 g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	88(69.44)	19.97	56.80	64.88	3.17	4.93	5.73
Mean	85(67.35)	19.49	53.94	61.06	2.87	4.14	4.88
SEm(±)	0.63	0.41	0.55	0.51	0.18	0.14	0.13
CD (p=0.05)	1.88	NS	1.66	1.53	NS	0.43	0.38

*Figures are in parenthesis are arc sin transformed values NS – Non-significant, DAS- Days after sowing

and 9.47, respectively), 60 DAS (56.80 cm, 4.93 and 24.70, respectively) and at 90 DAS (64.88 cm and 5.73, respectively) over the control (Table 1 & 2). The significant increase in plant growth due to biopelleting which may be ascribed for enhanced N and P nutrient uptake, it might be due to the synthesis and oxidation of plant growth promoting substances like IAA and GA_3 [4, 5] and also, because of early emergence and vigorous establishment of the plant.

Significantly higher chlorophyll content (SPAD value) was recorded in case of seeds biopelleted with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata*@ 50g kg^{-1} of seed at 30 and 60 DAS (36.55 and 45.54, respectively) which was followed by seeds treated with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed (35.89 and 44.01, respectively), while the lowest SPAD value was recorded in plots of control (31.37 and 38.11, respectively) (Table 2). Increase in chlorophyll status of leaf may be related with leaf nitrogen content which indicates that chlorophyll content in leaf was positively affected by nitrogen levels, higher rate of nitrogen fixation, increased chlorophyll synthesis and photosynthesis by the plants, due to biopelleting [6, 7]. The significant variation with highest NDVI value at 30 (0.843) and 60 DAS (0.863) were recorded in seeds biopelleted with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50 gkg^{-1} of seed and it was on par with seeds treated by *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed (0.830 and 0.847, respectively) pelleted seeds, while lowest NDVI value was in control (0.760 and 0.793, respectively) (Table 2). This might be due to changes in red and NIR reflectance, which have been attributed to total chlorophyll content and biomass, also higher rate of nitrogen fixation, increased chlorophyll synthesis and photosynthesis by the plants [6, 7].

The seeds pelleted with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed induced early flowering by 3.34 days, which was on par with seeds treated by *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed by 3.0 days (Table 2). The increased rate of emergence results in early flowering and harvest. Similar observations in the advancement of flowering were also reported in sunflower [8], Pearl millet [9], maize [10] and in sunflower [11]. The seed yield was found significantly higher in seeds treated with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed (21.41 q/ha) and it was on par with other three dual combination treatments like. *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed (21.39 q/ha), *Rhizobium* Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed (21.37 q/ha) and *Rhizobium* Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @

Table 2. Effect of biopelleting on number of trifoliate leaves per plant, days to 50% flowering, chlorophyll content and normalized difference vegetative index in soybean

Treatments	Number of trifoliate leaves		Days to 50% flowering	Chlorophyll content (SPAD Value)		Normalized Difference Vegetation Index	
	30DAS	60DAS		30DAS	60DAS	30DAS	60DAS
Control	9.00	19.13	41.67	31.37	38.11	0.760	0.793
Rhizobium Sb-120 @ 25g kg^{-1} of seed	9.17	20.77	41.00	33.23	40.73	0.793	0.823
Rhizobium Sb-120 @ 50g kg^{-1} of seed	9.23	22.20	40.33	34.41	43.07	0.810	0.840
Pseudomonas striata @ 25g kg^{-1} of seed	9.13	20.33	41.33	32.90	39.65	0.783	0.817
Pseudomonas striata @ 50g kg^{-1} of seed	9.23	21.93	40.67	33.93	42.15	0.807	0.833
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	9.30	22.60	39.00	34.85	43.53	0.813	0.837
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	9.33	23.10	39.00	35.23	43.99	0.823	0.843
Rhizobium Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	9.40	23.30	38.67	35.89	44.01	0.830	0.847
Rhizobium Sb-120 @ 50 g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	9.47	24.70	38.33	36.55	45.54	0.843	0.863
Mean	9.25	22.01	40.00	34.26	42.31	0.807	0.833
SEm(±)	0.25	0.34	0.59	0.43	0.38	0.007	0.007
CD (p=0.05)	NS	1.02	1.75	1.27	1.14	0.020	0.022

25g kg^{-1} of seed (21.35 q/ha) treated seeds. Increase in seed yieldmay be attributed to increase in the yield contributing parameters like pod length, pod weight per plant, number of pods per plant, number of seeds per pod, hundred seed weight, yield per plot and yield per ha. Among the treatments seeds pelleted with *Rhizobium* Sb-120 @ 50 gkg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed has increased 15.98% seed yield over control (Table 3). Influence of bio-fertilizers on the yield might be through their effect on actively growing regions in such a way that they encourage nitrogen fixation and phosphorous solubilization and mobilize the nutrients absorbed elsewhere towards the shoot resulting in better vegetative growth and subsequent yield in soybean [12, 13]. Compared to sole application of biofertilizers combined application recorded the significant increase in the yield which may be because of the synergetic relationship between the two biofertilizers [14]. All the biopelleting treatments improved the growth of plant either alone or in combination during early stage of crop with vigorous and stronger root system enabling plants to derive the available soil moisture and nutrients which resulted in enhanced growth and seed yield. It could be concluded that the soybean seeds pelleted with *Rhizobium* Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed recorded higher yield and seed yield parameters.

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Table 3. Effect of biopelleting on pod length, pod weight, number of pods, number of seeds, seed yield and 100 seed weight in soybean

Treatments	Pod length (cm)	Pod weight/ plant (g)	Number of pods/plant	Number of seeds per pod	Seed yield (q/ha)	100 seed weight (g)
Control	2.97	0.253	71.40	2.57	18.46	12.54
Rhizobium Sb-120 @ 25g kg^{-1} of seed	3.21	0.271	80.07	2.72	19.16	13.35
Rhizobium Sb-120 @ 50g kg^{-1} of seed	3.33	0.285	85.47	2.76	20.37	13.58
Pseudomonas striata @ 25g kg^{-1} of seed	3.15	0.269	78.60	2.69	19.04	13.31
Pseudomonas striata @ 50g kg^{-1} of seed	3.25	0.279	83.40	2.74	20.22	13.53
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	3.41	0.305	92.13	2.83	21.35	13.81
Rhizobium Sb-120 @ 25g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	3.57	0.311	93.33	2.85	21.37	13.82
Rhizobium Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 25g kg^{-1} of seed	3.60	0.327	94.50	2.89	21.39	13.83
Rhizobium Sb-120 @ 50g kg^{-1} of seed + *Pseudomonas striata* @ 50g kg^{-1} of seed	3.69	0.338	95.27	2.91	21.41	13.83
Mean	3.35	0.293	86.02	2.77	20.31	13.51
SEm(±)	0.10	0.011	0.99	0.03	0.06	0.07
CD (p=0.05)	0.31	0.032	2.97	0.10	0.17	0.22

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