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Research paper

Effect of seed pelleting on growth, yield and seed quality parameters of black gram

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ABSTRACT

Seed pelleting involves encasing seeds in inert material using carefully chosen powder and liquid. This method facilitates enhancing seed placement, sowing, germination, and shields plants from various biotic and abiotic stresses. In the context of Indian agriculture, pulse production faces significant challenges due to low production and productivity. Therefore, seed pelleting holds immense promise in addressing these limitations. This study underscores the significance of seed pelleting concerning growth, yield, and quality parameters. The findings concluded that seeds treated with pelleting exhibited superior growth attributes, such as increased plant height, branch numbers, and higher dry matter production. Additionally, seeds pelleted with rhizobium displayed elevated levels of chlorophyll 'a', 'b', and total chlorophyll content. Furthermore, rhizobium-treated pelleted seeds demonstrated the highest yield compared to other treatments and the control group.

Key words: Black gram, Botanical seed pelleting, Morpho-physiological characters, Seed quality, Rhizobium

INTRODUCTION

Black gram [*Vigna mungo* (L.) Hepper] is grown in about 3.10 m ha with a yield of 1.40 mt during 2021-22. India is the world's largest producer and consumer of pulses, accounting for 35% and 25% of the world's area and production, respectively (Tiwari and Shivhare, 2016). Pulses have a unique place in cropping systems of wetland, dry land, or rainfed agriculture as a soil fertility restorer. The massive leaf fall enriches soil organic matter and it also helps to fix substantial amounts of atmospheric nitrogen through symbiosis, reducing the need for artificial fertilizers. Pulses are also important for providing human beings with protein-rich meals and for supporting soil health and crop output over time. Pulses are high in protein and grown in more than 78% of the world's countries (Ananthi *et al.*, 2015).

The production of pulse crops in India is significantly lower than the global average. In India, the average productivity of black gram crop has rather remained static (343 kg/ha) due to several reasons. Aside from the genetic makeup, poor germination, insufficient assimilate partitioning, poor pod setting due to flower abscission, and lack of nutrients during critical stages of crop growth as well as several pests and diseases, resulted in the low yield. To increase the production of black gram, several ways have been implemented (Elamathi, 2007). One of them is seed pelleting with botanicals, which will provide an initial boost for germinating seeds and growing seedlings, allowing for greater root and shoot growth and, as a result, increased drought tolerance and yield. Seed pelleting has a lower cost, but its benefit to farmers is more (Dileepkumar *et al*., 2009).

Many studies have shown that using leaf powders can increase crop production in a variety of crops. Pre-storage dry treatments with ferulic acid, aspirin, and para-aminobenzoic acid increased the storability and field performance of stored soybean seed (Bhattacharya *et al*., 2015). The vigour of the seedling is a critical aspect of crop output, and it is often assumed that large seeds produce more vigorous seedlings than small, ungraded seeds (Mandal *et al.,* 2003). Mandal *et al*. (2003) and Sengupta *et al*. (2005) found that dry seed vigoration treatments improved viability and emergence in a variety of other crops, and hypothesized that counteracting free radical reaction and lipid peroxidation could be the explanation. *Rhizobium* extract's anti-oxidant properties have been well documented by Yadav *et al*. (2011).

As a result, seed pelleting with botanicals has become increasingly popular in recent years. Hence, tests were conducted to investigate the effects of botanical seed pelleting on morpho-physiological characteristics, leaf chlorophyll, germination, pod length, pod girth, growth, yield, and seed quality parameters in black gram.

MATERIALS AND METHODS

Laboratory and field experiments and subsequent analysis were carried out in the Department of Genetics and Plant Breeding, Faculty of Agriculture at Annamalai University, Tamil Nadu, India (2016-2017). The field is situated at 11°24′ North latitude and 79°69′ East longitude at an altitude of 5.79 m above mean sea level. The soil of the experimental field was clayey loam. Genetically pure seeds of black gram cv. ADT-3 obtained from Tamil Nadu Agricultural University, Coimbatore was used for the present study.

Seed treatment

The seeds are uniformly coated with adhesive in the correct quantity initially with the following -

Control, Red algae sea weed @ 1%, Brown algae sea weed @ 1%, Green algae sea weed @ 1%, *Trichoderma viride* @ 4 g/kg, *Rhizobium* @ 600 g/ha (3 packets), Phosphobacteria @ 600 g/ha (3 packets), Sodium molybdate 300 mg/kg, $ZnSO_4$ @ 300 mg/kg and $MgSO_4$ @ 300 mg/kg

Method of seed pelleting

Before imposing seed treatment, the seeds were manually cleaned and the required quantity of seed was taken into a container to which 5 percent of gum arabica as adhesive was added @ 400 ml per kg of seed and mixed thoroughly by shaking and rotating the container. The pelleting materials were treated with red algae seaweed extract @ 1%, Brown algae seaweed extract @ 1%, Green algae seaweed extract @ 1%, *Trichoderma viride* @ 4 g/kg, Rhizobium @ 600 g/ha (3 packets), Phospho-bacteria @ 600 g/ha (3 packets), Sodium molybdate 300 mg/kg, $ZnSO_4$ @ 300 mg/kg and $MgSO_4$ @ 300 mg/kg were added into the container containing the seeds and continuous shaking and rotating were done for uniform coating of the micronutrient onto the seeds. The pelleted seeds were dried for 24 hours and used for both sowing in the field and laboratory studies. The dry normal seed was used as a control.

Laboratory testing

Before being evaluated for morphophysiological features, the pelleted seeds were dried in the shade for two days. The germination test was carried out using the ISTA method (1999). The germination test was carried out in the germination room using the between-paper method with four replicates of one hundred seeds each at a temperature of 25 °C. Based on the usual seedling count on the 10th day, the germination (%) was calculated and expressed as a percentage. Magurie's (1962) formula was used to calculate the percentage of seeds that germinated (ISTA 1999).

After the germination test, the root length of ten healthy seedlings was measured. The root was measured in centimeters from the collar to the tip, and the average value was recorded and displayed in centimeters. Shoot length was measured using the same seedlings that were used to determine root length. The length was measured from the collar to the first leaf's tip, and the average value was recorded and represented in cm.

The seedlings used to measure growth were wrapped in paper and dried in the shade for 24 hours before being baked at 85 °C for 24 hours. The average value in mg per seedling was calculated after weighing the dried seedlings. The seedling's vigour index was calculated using the formula proposed by Abdul-Baki and Anderson (1973).

Vigour index = Germination (per cent) × Dry matter production

Field evaluation

A field trial was conducted in a randomized block design. The crop was planted at 30 × 10 cm spacing and the recommended practices were used. Proper watering was done at critical phases of flowering and pod development, and observations on growth, gas exchange, and yield characteristics were documented.

The plant's height was measured from ground level to the tip of the main branch on a meter scale, with the mean value reported in centimeters. The total number of branches per plant was counted, and the mean number was recorded as a whole number. A total of ten seedlings' biomass production was measured.

Statistical analysis

All obtained data from the experiment were statistically analyzed by analysis of variance

(ANOVA) according to randomized block design as prescribed by (Panse and Sukhatme, 1978). The standard error of the mean in each case and critical difference only for significance cases were computed at 5% levels of probability.

RESULTS AND DISCUSSION

Growth parameters

The seeds pelleted with *Rhizobium* @ 600 g/ha (3 packets) recorded higher values for growth parameters such as plant height (71.86 cm), number of branches (14.66), dry matter production (10.20 g/plant) and lower 50% flowering (31.65), whereas the control treatment had lower values for all of the above growth parameters (Table 1 and 2). Plant height is an important requirement for a crop since it allows for more bloom production and thus a higher yield (Tiwari *et al.,* 2016). *Rhizobium* improved the plant's growth characteristics by triggering the biosynthesis of nucleic acid, proteins, and hydrolytic enzymes, which improved cell division, cell enlargement, metabolic activity, and the photosynthetic process, resulting in increased nutrient uptake by efficient and stronger roots (Elamathi, 2007). The initial vitality of the *Rhizobium* invigorated seeds may have stimulated seedling growth and facilitated higher nutrient absorption by the foliage, resulting in faster growth and a greater number of branches per plant (Ayumi *et al.,* 2004). Similar findings were made by Dileepkumar *et al.* (2009). The inclusion of ammonia nitrogen, phosphorous, and other critical micronutrients in the pelleting mixture could explain the increased number of branches and plant height (Rizvi *et al.,* 2012). The improvement in field emergence could be ascribed to cell activation, which increased mitochondrial activity, resulting in the synthesis of additional high-energy compounds and essential biomolecules available during the early stages of germination. These findings are on par with the results of Ananthi *et al.* (2015).

Leaf chlorophyll content

Rhizobium @ 600 g/ha (3 packets) had the highest chlorophyll 'a' content (0.98 mg/g) among the seed pelleting treatments, followed by seeds pelleted with Green algae seaweed extract @ 1% (0.91 mg/g) and control seed, which had the lowest chlorophyll 'a' content (0.51 mg/g) (Table 2). Similar results were obtained with rhizobium and seeds pelleted with Prosopis leaf powder @ 50 g/kg for chlorophyll 'b' and total chlorophyll concentrations. Increased chlorophyll 'a', 'b', and total chlorophyll reported in *Rhizobium* pelleting @ 150 g/kg could be attributable to maximum chemical energy production and plant metabolism, resulting in plant development (Ayumi *et al.,* 2004).

Because of the Prosopis energizing impact, the plants would have taken more nutrients from the soil and used them to produce more chlorophyll, resulting in increased photosynthetic activity in the treated plants. These results were on par with the findings of Sathiya Narayanan *et al.* (2015). This increase could also be attributed to the presence of mineral elements such as nitrogen, potassium, and calcium, all of which are important in chlorophyll production (Prakash *et al.,* 2013). Organic matter treatment improved chlorophyll content, according to Mahmood *et al*. (2007). Rizvi *et al*. (2012) also found higher chlorophyll concentrations in botanicals including *Argemone mexicana*, *Calotropis procera*, *Solanum xanthocarpum,* and *Eichhornia echinulata*.

Yield parameters

When compared to the other treatments and the control, all yield parameters were shown to be improved in the rhizobium pelleting treatment @ 150 g/kg (Table 2). The *Rhizobium* @ 600 g/ha (3 packets) had the longest pod length (8.10 cm), more seeds per pod (8.66), the highest seed yield per plant (99.13 g), the highest seed yield (813 kg/ha), and the highest seed weight (7.1 g), compared to the untreated seeds that had the lowest values (pod length – 4.27 cm, seeds per pod- 6.22, seed yield per plant-8.07 g, seed yield – 617 kg/ha and seed weight – 5.18 g). Physiologically active substances may have activated the embryo and other associated structures, resulting in increased water absorption due to cell wall elasticity and the development of a stronger and more efficient root system. This may have favoured the derivation of more nutrients, resulting in increased yield. Increased pod yield could be attributed to sugars being translocated from complex molecules like carbs at a faster pace. These findings are in concordance with the reports of Dileepkumar *et al*. (2009).

Increased pollen production and fertilization may have increased the number of filled seeds leading to increasing the quantity of seeds. Singh (1982) found that rhizobia includes 1.16% nitrogen, 0.14% phosphorus, and 0.49% potassium, as well as different alkaloids such as pinnalin, pongamol, Saponin, sitosterol, and tannins. The saponins in the pongamia leaf extract may have improved nutrient absorption while also protecting the seedlings from infections (Sathiya and Muthuchelian, 2010). *Rhizobium* pelleting may have induced increased protein synthesis, which may have aided amino acid rescue and protein turnover during active metabolism later in plant life.

The presence of auxin-like chemicals in leaf extract, which affects plant growth and initial establishment, could explain the increase in yield metrics of pelleted seeds. The inclusion of growth regulators like GA3 may boost the activity of dehydrogenase, amylase, and peroxidase enzymes, resulting in higher seed production in *Rhizobium* pelleted seeds (Shehzad *et al.,* 2012). The improvement in yield parameters could be attributed to the *Rhizobium*'s bioactive compounds, which cause the synthesis of gibberellin leading to a boost in germination % by speeding up the germination process, resulting in an increased crop growth and development and improved yield. Prakash *et al*. (2013) observed similar findings with enhanced yield metrics. Due to the use of *Rhizobium*'s bioactive compounds, increased yield and yield characteristics have been recorded in black gram (Prakash *et al.,* 2012), bhendi (Prakash *et al.,* 2014), and rice (Prakash *et al.,* 2013).

Table 1. Effect of seed pelleting on growth parameters of black gram

Seed treatment	Germination (%)	Speed of germination	Plant height at 45 DAS (cm)	Plant height at maturity (cm)	Days to first flowering	No. of branches/ plant	No. of seeds/ pods	Pod length (cm)
Control	72	10.1	9.33	49.9	28.6	9.32	6.22	4.27
Red algae sea weed @ 1%	78.9	10.6	10.3	54.3	26.4	10.4	6.68	5.06
Brown algae sea weed @ 1%	81.7	11	10.9	57.4	26.8	11.3	6.93	5.49
Green algae sea weed @ 1%	84.6	11.2	11.5	58.9	27.8	12.2	7.31	5.92
Trichoderma viride @ 4 g/kg	96.2	12.5	13.8	69.6	31.7	14.2	8.5	7.43
Rhizobium @ 600 g/ha (3 packets)	93.9	12.3	13.4	71.9	25.5	13.6	8.66	8.1
Phosphobacteria @ 600 g/ha (3 packets)	76.7	10.4	9.93	52	30.6	9.77	6.51	4.83
Sodium molybdate 300 mg/kg	90.7	12	12.5	64.9	29.6	13	7.72	6.63
$ZnSO_4$ @ 300 mg/kg	98	12.8	12.9	67.4	32.3	12.6	8.85	7.86
$MgSO_4$ @ 300 mg/kg	87.7	11.6	12.1	61.5	24.7	14.7	7.79	6.24
SEm±	0.12	0.03	0.05	0.39	0.07	0.14	0.05	0.03
CD (P=0.05)	0.3	0.09	0.14	1.06	0.21	0.3	0.2	0.1

Table 2. Effect of seed pelleting in seed yield and quality parameters of black gram

Seed treatment	Pod girth (cm)	100 seed weight (g)	Root length (cm)	Shoot length (cm)	Dry matter production (g)	Vigour index	Protein content (%)	Chlorophyll content (mg/g)	Seed yield/ plant (g)	Seed yield (kg/ha)
Control	11.2	5.18	9.36	11.4	10.2	3305	18.3	0.51	8.07	617
Red algae sea weed @ 1%	11.9	5.56	11.2	12.8	18	3423	19.8	0.8	8.27	708
Brown algae sea weed @ 1%	12.3	5.77	11.8	13.8	11.1	3528	20.4	0.75	8.38	613
Green algae sea weed @ 1%	12.6	6.06	12.3	14.5	11.3	3596	20.8	0.93	8.45	555
Trichoderma viride @ 4 g/kg	14.5	6.72	15.6	17.5	12.5	3837	23.9	0.85	8.84	643
Rhizobium @ 600 g/ha (3 packets)	14	7.1	14.6	16.7	12.3	3768	23.2	0.98	9.13	813
Phosphobacteria @ 600 g/ha (3 packets)	11.5	5.4	10.3	12	10.4	3362	18.9	0.63	8.18	660
Sodium molybdate 300 mg/kg	13.6	6.37	13.9	16.2	12.1	3721	22.2	0.58	8.64	982
$ZnSO_4$ @ 300 mg/kg	14.9	6.92	16.5	18.4	12.8	3916	24.6	0.75	8.94	500
$MgSO_4$ @ 300 mg/kg	13.1	6.19	13.1	15.5	11.7	3654	21.4	0.65	8.51	783
SEm±	0.04	0.41	0.14	0.02	0.03	13.08	0.11	0.08	0.96	12
CD (P=0.05)	0.04	1.14	0.38	0.01	0.10	37.5	0.32	0.24	2.75	36

CONCLUSION

From the above study, it can be concluded that for better results in relation to growth, yield and quality parameters, seed pelleting is proven to be very effective. The seeds pelleted with Rhizobium recorded higher values for growth parameters such as plant height, number of branches, dry matter production and lower 50% flowering in comparison to control treatment. When compared to the other treatments and the control, all yield parameters were shown to be improved in the rhizobium pelleting treatment. Moreover, seeds treated with pelleting and rhizobium exhibited heightened levels of chlorophyll 'a', 'b', and total chlorophyll content.

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