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Effect of Seed Coating and Pelleting on Germination, Plant Establishment and Seed Yield in Cumin (*Cuminum cyminum* L.)

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Abstract: An investigation to study the effect of seed coating and pelleting on germination, plant establishment, and seed yield of cumin was conducted at ICAR-Central Arid Zone Research Institute, Jodhpur, during the Rabi season in the year 2016 and 2017. The field experiment was laid out in a randomized complete block design, comprising 18 treatments in three replications. Results revealed that, pelleting of seeds with lignite + *Azospirillum* significantly increased per cent field emergence (91.5%), plant height, umbels per plant, seeds per plant and seed yield as compared to other treatments. But seed yield parameters viz. days required for 50% **t** field emergence, plant height at harvesting time, days required for 50% flowering and seed test weight did not show significant variation with other treatments. Furthermore, an experiment on the storability of pelleted seeds in terms of germination percentage was conducted in a laboratory, and it was found that seeds pelleted with lignite and *Azospirillum* recorded the highest germination percentage (67%) at the end of a 6-month storage period. Overall, seed pelleting treatments with lignite + *Azospirillum* improved crop establishment, growth, and seed yield, and the pelleted seeds can also be stored for 6 months under ambient conditions.

Key words: Seed coating, seed pelleting, cumin, seed storage, seed germination.

Cumin (*Cuminum cyminum* L.) is a small, annual herbaceous plant with a glabrous, branching stem. It has a 3 to 5 cm diameter and a height of 30 to 40 cm. There are two to three sub-branches on each branch. The stem is dark green or grey. The length of the leaves is 5 to 10 cm, flowers are tiny, pink, or white blooms borne in umbels. Five to seven umbellets make up each umbel. The fruit has two pericarps and a single seed and is 4 to 5 mm long. There are around eight oil canals in the ridges of cumin seeds. Like other members of the Apiaceae family, they are oblong, longitudinally ridged, and yellow-brown in color (Hansaliya *et al*., 2022). Egypt and the Mediterranean region are the native home of cumin. Cumin is widely cultivated in India, China, South Russia, Japan, Indonesia, Iran, Morocco, Turkey, Egypt, and Argentina (Trivedi *et al.,* 2019).

Cumin is in high demand both domestically and internationally, which plays a crucial role in a country's economy. However, several factors are impeding cumin production and productivity. These factors include the availability of high-quality seeds, delayed and uneven germination, and poor adoption of effective seed production methods (Trivedi *et al.*, 2018). One effective strategy for producing high-quality seeds is seed treatment, which helps mitigate the negative effects on seed vigor and viability and enhances the conditions for seedling establishment, growth, and development. Despite its importance, there are relatively few studies focusing on pre-sowing seed treatments for cumin (Trivedi *et al.*, 2019).

Application of coating and pelleting cumin seeds with bio inoculants and filler, binder and growth materials can significantly enhance benefits in cumin cultivation. It improves seed handling and can significantly improve the efficiency and precision of line sowing, making it easier to plant small and light cumin seeds more uniformly. The coating provides a protective barrier against unfavorable soil conditions and thus safeguard the cumin seeds during their most vulnerable stages (Ines *et al.,* 2019). Additionally, filler, binder and other growth materials in the coating ensure a steady supply of moisture and nutrients directly around the seed, which promotes faster and more uniform germination, especially in challenging growing conditions (Jetiyanon *et al.,* 2008). Bio-inoculants added during pelleting further enhance plant health by improving nutrient uptake, fostering beneficial microbial interactions, and boosting the plant's natural tolerance to stresses (Jamir *et al.*, 2021). Overall, these enhancements would lead to stronger and healthier plants, better crop establishment, and ultimately, higher yields. This technique could be particularly valuable in areas with poor soil quality and where prevalence of other biotic and abiotic pressures is high (Ines *et al.,* 2019). This study was therefore undertaken to identify the best combination of growth promoters and bio-inoculants with seed coating for improving germination, growth, and yield of cumin, as well as enhancing the storability of cumin seeds.

Materials and Methods

The field experiment was conducted at ICAR-Central Arid Zone Research Institute, Jodhpur. The objective of the experiment was to know the effect of different seed pelleting treatments on crop establishment, growth and seed yield under field conditions. The experiment was conducted for two seasons during Rabi 2016 and 2017. An experiment was laid out in a randomized complete block design (RCBD) with 18 treatments combination and three replications. Treatment combinations were prepared using four different filler materials, four binders, four plant growth chemicals, and 3 different bio-inoculants. Details of the methodology are given in the following paragraph.

100 g clean seeds were first taken in round plastic trays. Then, 10 mL of binder material was added and the contents were shaken gently in such a way that the binder spreads evenly on the surface of each seed. Then 200 g (cumin) and 300 g (fennel) of filler material were added through the mesh which was covered over a round plastic tray in order to spread filler material evenly over the seeds and shaken clockwise and anti-clockwise until whole filler material coat over seeds and formation of uniform seed pellets. Seed dumps/clumps formed were separated during pelleting if any. Excess filler material left over was removed by sieving. Finally, the seed pellets were dried under the shade and used for field sowing after 24 hr. Before seed pelleting, seeds were treated with plant growth chemicals in the form of seed priming using an equal volume of solution and seed for 24 hr and dried in the shade. Bio inoculants were used during seed pelleting before applying filler material (5 ml binder and 5 g bio-inoculant were added and shaken gently in order to coat the inoculant over the seed surface. Subsequently again 5 mL binder was added followed by mixing with filler material.

Seed of cumin var. GC 4 seeds were procured from ICAR-National Research Centre on Seed Spices, Ajmer. Eighteen combinations of seed coatings with different material were prepared using combination of three types of fillers (lignite, bentonite, gypsum, and silica), four types of binders: polyvinyl alcohol (3%), gum arabic (2.5%), guar gum (2%), and methylcellulose (3%), four plant growth promoters borax (500 ppm), salicylic acid (500 ppm), ethrel (100 ppm), and ascorbic acid (100 ppm) and three bio-inoculants *Trichoderma* spp. (5 g 100 g^{-1} seed), *Azatobaztor* spp. (5 g 100 g^{-1} seed) and *Azospirillum* spp. (5 g 100 g^{-1} seed) to evaluate the effects of various seed coating materials and priming agents on seed performance. These 18 treatments were lignite + methyl cellulose , bentonite + methyl cellulose, silica + methyl cellulose, gypsum + methyl cellulose, lignite + gum arabic, bentonite + gum arabic, silica + gum arabic , gypsum + gum arabic, lignite + priming with borax, lignite + priming with salicylic acid, lignite + priming with ascorbic acid, lignite + priming with ethrel, lignite + hydropriming, lignite + bavistin, lignite + *Trichoderma,* lignite + *Azotobacter*, lignite + *Azospirillum* and control (no treatment).

Different growth and seed yield attributing characters were recorded *viz* 50% field emergence (days), field emergence (%), plant height at 30 DAS, plant height at harvesting time, umbels $plant^{-1}$, seeds $plant^{-1}$, test weight (g) and yield (g m^{-2}/kg ha^{-1}).

A separate laboratory study was conducted after harvest to address the concerns related to the seed storability using all the 18 treatments. which were formulated for field experiments in a completely randomized design (CRD). Seed germination percentage was recorded at monthly intervals for 6-month storage period. Around 25 seeds placed per petri plate and evenly spaced on a moistened filter paper within the plate. This ensures adequate space for germination and growth without overcrowding. The temperature setting for the BOD incubator was kept 25°C for cumin seed germination. Regularly germination was monitored for recording germination percentage.

Standard error of the mean (SEm ±) and critical difference (CD) at a 5% level of probability were calculated from the recorded data as per Panse and Sukhatme (1985).

Results and Discussion

The effect of different pelleting treatments on seed yield in cumin varied significantly. Seed pelleting treatments did not showed significant variations in the number of days to reach 50% field emergence, the lignite + *Azospirillum* treatment showed relatively less duration (7.2 days) than control condition (10 days) to achieve 50% field emergence. Field emergence with lignite + *Azospirillum* was maximum (91.5%) while it was minimum in treatment of lignite + methyl cellulose (67.7%). Similar trend was recorded for plant height at 30 days. Jamir *et al* (2021) had also reported improvement in plant height with seed treatment of *Azospirillum*. Improved nutrients availability by *Azospirillum* could explain better plant growth. Similar findings were reported by Valadabadi and Farahani (2013) for black cumin, where the maximum plant height (84 cm) was observed with the application of *Azotobacter* and animal manure. A similar result was also recorded by Ali and Hassan (2014).

Different seed pelleting treatments did not show significant impact on 50% flowering and plant height at harvest however, minimum days to 50% flowering were observed in treatments gypsum + methyl Cellulose, lignite + gum grabic, and lignite + *Azospirillum*, and maximum plant height (32.85 cm) at harvesting was recorded in lignite + *Azospirillum*. The number of umbels $plant^{-1}$ was significantly affected by different seed pelleting treatments. The maximum number of umbels $plant^{-1}$ was recorded in treatment lignite + *Azospirillum* followed by other treatments, treatment Lignite + Hydro priming showed the minimum (17.95) umbels $plant^{-1}$. The application of 75% RDN + RDPK + FYM + *Azospirillum* + phosphorus solubilizing bacteria in fennel lead to the maximum value in yield attributes, including umbels $plant^{-1}$, umbellets $umbel^{-1}$, seeds $umbellet^{-1}$, and predicted yield, according to Kusuma *et al*. (2019).

Maximum (1421.4) seeds $plant^{-1}$ were recorded in the treatment lignite + *Azospirillum* which were statistically on par with treatment gypsum + gum arabic and the treatment lignite + priming with salicylic acid while minimum (488.35) number of seeds $plant^{-1}$ were recorded in treatment lignite + priming with ascorbic acid. According to Abdel-Azieza *et al.* (2013), using *Azotobacter* with a half-dose of nitrogen fertilizers increased the quality and productivity of black cumin. Lignite + *Azospirillum* recorded the maximum test weight among all the treatments. Similar findings were recorded by Sahu *et al*. (2014) in coriander, and Hellal *et al*. (2011) in dill.

Significant variations were observed in the yield showing the effect of different

Table 1. Effect of different pelleting treatments on filed emergence, growth, flowering and seed yield parameters in cumin

Treatments	50% field emergence (Days)	Field emergence (%)	Plant height at 30 DAS (cm)	50% flowering DAS (Days)	Plant height at harvesting time (cm)	Umbels per plant	Seeds per plant	Test weight (g)	Yield g m^{-2}	Yield (kg ha^{-1})
Lignite + Methyl Cellulose	9.0	67.7	9.85	70.3	28.8	22.55	844.35	4.15	68.17	681.7
Bentonite + Methyl Cellulose	8.0	72.0	10.5	70.0	30.2	19.35	602.95	4.40	69.00	690.0
Silica + Methyl Cellulose	9.0	80.8	12.6	69.3	30.7	24.25	838.40	4.10	68.30	683.0
Gypsum + Methyl Cellulose	9.0	74.0	12.7	69.0	28.6	24.95	494.35	4.20	74.25	742.5
Lignite + Gum Arabic	8.3	76.5	13.5	69.0	27.8	20.45	623.05	4.20	75.15	751.5
Bentonite + Gum Arabic	8.3	77.5	13.9	70.0	29.2	24.15	651.90	4.40	72.10	721.0
Silica + Gum Arabic	8.7	63.2	10.8	69.3	28.1	26.15	587.30	4.30	79.87	798.7
Ypsum + Gum Arabic	8.3	81.7	14.4	69.3	27.9	26.45	1397.5	4.10	82.30	823.0
Lignite + priming with borax	7.9	74.5	13.3	69.6	29.1	24.45	967.70	4.45	80.25	802.5
Lignite + priming with Salicylic acid	9.0	73.8	13.1	70.6	28.4	23.8	1054.9	4.35	79.45	794.5
Lignite + priming with Ascorbic acid	8.3	82.0	12.1	69.6	29.0	18.75	488.35	4.45	71.47	714.7
Lignite + priming with Ethrel	8.7	81.2	11.0	69.6	27.8	19.00	758.95	4.35	72.40	724.0
Lignite + Hydro priming	9.0	77.0	12.9	69.3	30.2	17.95	741.35	4.30	76.65	766.5
Lignite + Bavistin	7.7	81.5	11.3	69.3	27.9	18.40	644.95	4.10	73.55	735.5
Lignite + *Trichoderma*	9.0	79.5	13.7	70.3	29.2	22.15	816.10	4.45	70.75	707.5
Lignite + *Azotobacter*	8.3	79.3	13.0	69.6	29.9	26.75	696.95	4.30	78.00	780.0
Lignite + *Azospirillum*	7.2	91.5	15.1	69.0	32.8	28.10	1421.4	4.50	91.20	912.0
Control/No treatment	10	79.5	11.4	70.0	28.7	21.90	797.30	4.30	77.05	770.5
SE(m) ±	0.69	4.3	0.93	1.1	1.6	2.52	195	0.12	3.134	31.34
CD @ 5%	ns	12.6	2.69	ns	ns	7.28	466	ns	9.429	94.28

seed pelleting treatments. Maximum (91.2 g m^{-2}) yield was recorded in treatment lignite + *Azospirillum* which was statistically at par (82.3 g m^{-2}) with the treatment of gypsum + gum Arabic. Lowest (68.175 g m^{-2}) yield was recorded in the treatment of lignite + methyl cellulose. Jamir *et al.* (2021) had also reported yield enhancement in black cumin following application of *Azospirillum* + phosphorus solubilizing bacteria + potassium solubilizers.

Table 2. Effect of seed storage period on germination % of the coated and pelleted seed in cumin

Treatments	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May 2017	Jun. 2017
Lignite + Methyl Cellulose	86	86	80	72	68	55
Bentonite + Methyl Cellulose	80	82	79	70	63	58
Silica + Methyl Cellulose	96	88	89	81	72	64
Gypsum + Methyl Cellulose	82	80	76	68	59	51
Lignite + Gum arabic	90	91	84	76	67	59
Bentonite + Gum arabic	84	84	80	72	63	55
Silica + Gum arabic	86	88	80	73	64	57
Gypsum + Gum arabic	89	88	83	76	67	60
Lignite + Priming with borax	92	93	80	73	64	61
Lignite + Priming with salicylic acid	90	88	80	73	64	56
Lignite + Priming with ascorbic acid	89	88	83	76	69	62
Lignite + Priming with ethrel	94	92	80	73	66	58
Lignite + Hydro priming	92	92	80	73	66	58
Lignite + Bavistin	88	87	83	76	69	62
Lignite + *Trichoderma*	81	78	68	61	54	46
Lignite + *Azotobactor*	92	92	80	71	64	56
Lignite + *Azospirillum*	97	95	92	83	76	67
Control/No treatment	92	92	88	79	72	63
SE(m) ±	1.38	0.62	0.79	0.17	3.61	3.40
C.D.@ 5%	0.48	0.21	0.27	0.05	1.20	1.13

Similar results have been reported by Kusuma *et al*. (2019) for fennel and Abdel-Azieza *et al*. (2013) and Hadi *et al*. (2012) in black cumin.

The results of the storage study showed that lignite pelleting with *Azospirillum* coating has significantly recorded the highest seed germination after 3 months of storage in cumin crops compared to all other treatments (Table 2).

Conclusion

Cumin is a very small seed crop. For a crop to be grown successfully, seed germination, seedling vigor, and other seed characteristics are essential. The pre-sowing seed pelleting with Lignite + Azospirillum improves nearly all plant traits positively viz., plant height at 30 DAS, field emergence, umbels per plant, seeds per plant and seed yield. As a result, it is revealed that seed pelleting before sowing can improve cumin crop production.

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