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Effect of seed pelleting on yield and storage quality in fennel (*Foeniculum vulgare* Mill.)

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Abstract

The current investigation on the effect of seed pelleting on germination, plant establishment and seed yield in fennel was carried out in two seasons during Rabi 2017 and 2018. The experiment consisted of 17 seed pelleting treatments along with the control. Field emergence (93.1 %), umbels per plant (26.61) and seed yield (1376 kg ha^{-1}) were highest in seeds pelleted with Lignite +A*zospirillum* and higher number of seeds per plant (397) was obtained in Lignite+Gum Arabic, whereas, days to 50 % field emergence, plant height and test weight showed non-significant differences among the treatments. Lignite + gum Arabic pelleting recorded maximum seed germination (65 %) at the end of six months storage period. In general, seeds pelleted with Lignite and coated with A*zospirillum* showed better performance both in terms of yield and storability.

Keywords: Seed coating, seed pelleting, fennel, seed storage, seed germination.

Introduction

Fennel (*Foeniculum vulgare* Mill.), a plant with almost hair-like, soft and feathery foliage and belongs to family of Apiaceae which is known as sweet cumin or saunf also. It is a widely produced crop that does well in mild climates and is farmed extensively for its favorable and palatable leaves as well as fruits, especially parts of North India as a rabi season crop. It was originally found in the Mediterranean region, but it has since spread throughout the world, particularly in Europe as well as North America. Today, mostly it is grown in Canada, Mexico, India, Iran, Bulgaria, Russia, China, Egypt, Turkey and Morocco. In India, it is grown in Gujarat, Rajasthan, West Bengal, Madhya Pradesh, Karnataka, Telangana, Punjab, Uttar Pradesh, and Haryana (Singh *et al.*, 2020).

The fennel plant is useful in its entirety. Fennel's aromatic fruits are used in a variety of food preparations, including soups, sauces, pastries, meat dishes, confections, pickles and liquors (Ehsanipour *et al.*, 2012). Fennel leaves are also used for culinary tradition as garnishes, salad ingredients, and as a vegetable for its enlarged base. Dried fruit of the fennel known as the fennel seed, is used as a spice, either whole or crushed. It is one of the classic Chinese five-spice blends with five ingredients and a key component in Italian sausages. Fennel's dried fruits have a fragrant and delicious aroma, making them ideal for mastication. The fennel fruit's essential oil is extremely important to the food sector (Zoubiri *et al*., 2014).

In a coating system or a part of a coating system, film coating is adaptable. Colorants give seeds an aesthetic appeal, helping color-code various varieties and improve the seed visibility after planting. Because there is less friction between the seeds, film coated seeds have improved flow property in the planter (Hill, 1997). An excellent way to apply chemical or biological treatments of seed is through film coating (Taylor *et al.*, 1994; McGee, 1995). Relatively high loading rates of plant protectants can be applied with film coating. However, unlike what is described for pellet loading, separation between plant protectants and seeds surface is not established. The goal of utilization of film-coating is to minimize workers exposure to toxic substances from treated seeds (EL-Attar *et al.,* 2016)

Technologies for coating of seed can be used for two things, i.e. they can help with mechanically sowing for achieving uniform plant spacing and they can serve as a carrier for plant pesticides. Materials can be used in the target area such that there is little impact on ecology of soil as well as environment (Taylor *et al*., 1998). A technique for evenly applying ingredients on seeds that have been borrowed from the pharmaceuticals and confectioneries industry is film coating. According to Halamer (1998) and Robani (1994), the formulation for making films is made up of a combination of plasticizer, polymer and colorant. Commercial formulations are available as dry powders or ready-to-use liquids (Ni, 1997). When the film-forming combination is applied, the material is deposited uniformly on each seed with minimal difference between seeds (Halmer, 1998). It has been claimed that the produced film acts as a physical barrier, which may limit oxygen transport to the embryo and lessen the leaching of inhibitors from seed coverings (Duan & Burris, 1997).

Materials and methods

The field experiment was conducted at Research Farm and Division of plant improvement and integrated pest management, ICAR-Central Arid Zone Research Institute, Jodhpur. The objective of the experiment was to study the effect of different seed pelleting treatments on crop establishment, growth, and seed yield of fennel under field conditions. The experiment was conducted for 2 seasons during Rabi 2016 and 2017 in a randomized complete block design (RCBD) with 18 treatments combinations and three replications. Treatment combinations were prepared using four different filler materials, four binders, four plant growth chemicals, and 3 different bio-inoculants.

Materials used

Seed material: Seeds of fennel variety AF1 were collected from ICAR-National Research Centre on Seed Spices Ajmer and used in the experiment

Fillers: Lignite, bentonite, gypsum, and silica

Binders: Polyvinyl alcohol (3%), Gum Arabic (2.5%), Guar gum (2%), and Methyl cellulose (3%)

Plant growth chemicals: Borax (500 ppm), salicylic acid (500 ppm), ethrel (100 ppm), and ascorbic acid (100 ppm)

Bio-inoculants: *Trichoderma* spp. (5g/100g seed), *Azatobaztor* spp. (5g/100g seed) and *Azospirillum* spp. (5g/100g seed)

Seed pelleting protocol

Quantity of filler materials: For every 100 g of fennel seed, 300 g of filler material was used to get the required size of the pelleted seeds.

Treatment details: Lignite+Methyl cellulose (T1), Bentonite+ Methyl cellulose (T2), Silica+ Methyl cellulose (T3), Gypsum+ Methyl cellulose (T4), Lignite+Gum Arabic (T5), Bentonite+ Gum Arabic (T6), Silica+ Gum Arabic(T7), Gypsum+Gum Arabic (T8), Lignite +priming with borax (T9), Lignite +priming with salicylic acid (T10), Lignite +priming with ascorbic acid (T11), Lignite +priming with ethrel (T12), Lignite +hydro priming (T13), Lignite +Bavistin (T14), Lignite +*Trichoderma* (T15), Lignite +*Azotobactor* (T16), Lignite +*Azospirillum* (T17) and control (T18). Eighteen treatments including control were replicated 3 times in field experiments in randomized complete block design

Observations recorded

Different growth and seed yield attributing characters were recorded *viz.* 50 % field emergence (Days), field emergence (%), plant height at 30 DAS (cm), plant height at harvest (cm), umbels per plant, seeds per plant, test weight (g), seed yield (kg ha^{-1}). After harvest, seed germination percentage was recorded at monthly intervals for a six month storage period.

Analysis of data

Data were analyzed statistically as suggested by Panse and Sukhatme (1985) for randomized block design. The standard error of the mean (S.Em ±) and critical difference (CD) at 5% probability level were worked out.

Results and discussion

Pelleting had a significant effect on the field emergence of fennel seeds. Maximum field emergence (93.1 %) was observed in the seeds pelleted with Lignite + *Azospirillum* (T_{17}) which was at par with T_{12}- Lignite + priming with ethrel and T_{16}- Lignite + *Azotobactor*, (89.9% and 89.6 %, respectively). The minimum field germination (79.1%) was recorded in T4- Gypsum+ Methyl cellulose. In 50 % field emergence (days), the treatments were on par but T_{17}-Lignite + *Azospirillum* showed the minimum (7.43) days for 50 % field emergence. Non-significant variations were observed among the treatments for plant height at 30 DAS (cm), days to 50 % flowering and plant height at harvest (Table 1).

Seed pelleting treatments had significant influence on umbels per plant and seeds per plant. The highest number of umbels per plant (26.61) was obtained in Lignite + *Azospirillum* treatment which was at par with treatment Silica + Gum Arabic and Lignite +*Azotobactor* (23.46). The lowest (16.81) number of umbels per plant was recorded in Bentonite+ Gum Arabic treatment. Kalasare *et al.* (2016), also found that treatment 100% RDN + *Azospirillum* + PSB + Vermicompost @ 2 t ha^{-1} recorded significantly more umbels per plant and seeds per umbel (173.69) than other treatments (Table 1). The increased nutrient availability in balanced quantity and accessible form may be a significant factor in the improved yield. The inoculation of *Azospirillum* and PSB together exhibits a processed effect and increases the availability of nitrogen and phosphorus to plants in the soil rhizosphere. Present findings are in conformity with the results of Pariari *et al.* (2015) and Mirshekari *et al.* (2010).

The number of seeds per plant was maximum (397) with the application of Lignite+Gum Arabic (T5) followed by T4-Gypsum+ Methyl cellulose (389) while the minimum (305) seeds per plant was observed in treatment T7 (Silica + Gum Arabic). Test weight (g) was on par among the different seed pelleting treatments and T11 recorded the highest (6.93 g) test weight among all the treatments.

Table 1. Effect of different pelleting treatments on seed yield

Treatment	Days to 50 % field emergence	Field emergence (%)	Plant height at 30 DAS (cm)	Days to 50 % flower-ing	Plant height at harvest (cm)	Umbels per plant	No. seeds per plant	Test weight (g)	Yield (kg ha^{-1})
T1	9.33	83.25	41.7	88	133.1	20.11	339	6.58	965
T2	9.53	84.6	35.95	90	138.3	20.31	348	7.13	918.6
T3	8.73	88.25	36.65	88	138	19.81	349	6.73	1,015
T4	8.83	79.1	36.4	87	135.3	17.24	389	6.53	1,098
T5	9.83	83.25	37.3	86	137.3	19.71	397	6.78	1,064
T6	10.33	84.75	36.7	90	136.1	16.81	329	6.53	1,003
T7	10.33	88.25	38.45	93	137.2	23.46	305	6.68	1,302
T8	9.33	84.4	33.95	94	138.3	19.46	367	6.68	1,027
T9	8.53	88.4	35.75	95	134.8	17.81	331	6.63	1,222
T10	8.33	84.1	36.3	91	135.5	19.81	322	6.73	1,107
T11	8.23	81.85	34.65	92	137.1	18.81	358	6.93	1,139
T12	10.33	89.9	33.25	87	139.6	19.46	348	6.83	1,164
T13	8.93	79.25	36.65	86	139	20.31	347	6.78	1,220
T14	8.32	82.6	35.5	85	132.5	21.81	325	6.88	1,200
T15	10.53	88.25	32.65	90	135	18.96	352	6.78	1,158
T16	9.23	89.6	32.65	91	135	23.46	333	6.63	1,150
T17	7.43	93.1	37.85	90	139	26.61	372	6.83	1,376
T18	9.54	84.65	31.7	94	133.5	22.11	352	6.63	1,131
SE(m) ±	0.003	1.65	0.223	2.13	3.22	1.52	3.786	0.07	56.18
C.D.@ 5%	NS	4.68	NS	NS	NS	4.39	10.90	NS	168.9

T1-Lignite+Methyl cellulose, T2-Bentonite+ Methyl cellulose, T3-Silica+ Methyl cellulose, T4-Gypsum+ Methyl cellulose, T5- Lignite+Gum Arabic, T6-Bentonite+ Gum Arabic, T7-Silica+ Gum Arabic, T8-Gypsum+Gum Arabic, T9- Lignite +priming with borax, T10-Lignite +priming with salicylic acid, T11-Lignite +priming with ascorbic acid, T12- Lignite +priming with ethrel, T13- Lignite +hydro priming, T14-Lignite +Bavistin, T15- Lignite +Trichoderma, T16- Lignite +Azotobacter, T17-Lignite +Azospirillum, T18-Control.

With respect to yield parameter, the highest seed yield (kg ha^{-1}) was recorded in treatment T17 (Lignite + *Azospirillum* (1,376 kg ha^{-1}) which was on par with treatment T7 (1302 kg ha^{-1}), T9 (1222 kg ha^{-1}) and T13 (1220 kg ha^{-1}) respectively while lowest seed yield (918.6 kg ha^{-1}) was obtained in treatment T2 (Bentonite+ Methyl cellulose) (Table 1). Kalasare *et al.* (2016)

reported that the significant impact of integrated nutrient management on the fennel seed yield was detected, which could be due to *Azospirillum*, which is an associative micro-aerophilic nitrogen fixer which helps to increase nitrogen availability. It colonizes the root mass, fixes nitrogen in loose connection with the plants, and causes the plant roots to exude mucilage, which lowers the oxygen level in the air and aids in fixing atmospheric nitrogen. Present findings were in conformity with the results of Pariari *et al*. (2015), Mirshekari *et al.* (2010) and Alipour *et al.* (2021).

Regarding the storage study, among the 18 treatments, T17 (Lignite pelleting with *Azospirillum* coating) recorded the maximum seed germination and T15 (Lignite + Trichoderma) recorded the least germination in the fennel crop after 6 months of storage (Table 2).

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

Treatment	Jan. 2017	Feb. 2017	March 2017	April 2017	May 2017	June 2017
T1	87	87	80	68	63	53
T2	81	83	79	66	58	56
T3	97	89	89	77	67	62
T4	83	81	76	64	54	49
T5	91	92	84	72	62	57
T6	85	85	80	68	58	53
T7	87	89	80	69	59	55
T8	90	89	83	72	62	58
T9	93	94	80	69	59	59
T10	91	89	80	69	59	54
T11	90	89	83	72	64	60
T12	95	93	80	69	61	56
T13	93	93	80	69	61	56
T14	89	88	83	72	64	60
T15	82	79	68	57	49	44
T16	93	93	80	67	59	54
T17	98	96	92	79	71	65
T18	93	93	88	75	67	61
SE(m) ±	1.5	1	0.5	3.5	63	2
C.D.@ 5%	4.49	2.99	1.49	NS	NS	5.98

T1-Lignite+Methyl cellulose, T2-Bentonite+ Methyl cellulose, T3-Silica+ Methyl cellulose, T4-Gypsum+ Methyl cellulose, T5- Lignite+Gum Arabic, T6-Bentonite+ Gum Arabic, T7-Silica+ Gum Arabic, T8-Gypsum+Gum Arabic, T9- Lignite +priming with borax, T10-Lignite +priming with salicylic acid, T11-Lignite +priming with ascorbic acid, T12- Lignite +priming with ethrel, T13- Lignite +hydro priming, T14-Lignite +Bavistin, T15- Lignite +Trichoderma, T16- Lignite +Azotobactor, T17-Lignite +Azospirillum, T18-Control.

Conclusion

The results of experiment show the beneficial effect of seed coating and pelleting on germination, plant establishment, and seed yield in fennel. Seed pelleted with Lignite + *Azospirillum* recorded maximum growth, yield attributes and maximum seed germination percentage after six months of seed storage.

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References

Alipour A, Rahimi M M, Hosseini S M A & Bahrani A 2021 Mycorrhizal fungi and growth-promoting bacteria improve fennel essential oil yield under water stress. Industrial Crops and Products. 170: 113792.

Duan X & Burris J S 1997 Film coating impairs leaching of germination inhibitors in sugar beet seeds. Crop Science. 37: 515–520.

Ehsanipour A, Razmjoo J & Zeinali H 2012 Effect of nitrogen rates on yield and quality of fennel (*Foeniculum vulgare* Mill.) accessions. Industrial Crops and Products. 35(1): 121–125.

EL-Attar M, Ebaid M, AL-Gezawe A & Abd El Gawad F 2016 Factors affecting mechanical coating of fennel seeds. J. Soil Sci. Agric Eng. 7(12): 973–979.

Halmer P 1998 Technical and commercial aspects of seed pelleting and film-coating, in Martin, T. (Ed.), Seed Treatment Progress and Prospects, Surrey, British Crop Protection Council. pp. 191–204

Hill H J 1997 New developments in seed technology, Proceedings of the Oregon Hort. Soc. Portland, Oregon, 88: 123–130.

Kalasare R S, Patel M V, Patel H K, Kadu S P, Patel A P & Umale A A 2016 Role of integrated nutrient management on growth attributes, yield attributes, and seed yield of rabi fennel (*Foeniculum vulgare* Mill.) in middle Gujarat condition. J. Pure and Appl Microbiol. 10(4): 3057–3062.

McGee D C 1995 Advances in seed treatment technology, Technical report no. 11, in McNicoll, A. (Ed.) Proc. Asia and Pacific Seed Assoc. New Delhi, APSA. pp. 1–14

Mirshekari B, Valizadeh N, Roudsari A M, Maleki S H, Farahvash F & Kouchebagh S B 2010 Improved growth and essential oil quality of *Foeniculum vulgare* by Azospirillum inoculation and nutrient seed priming. J. Food Agric. Environ. 8: 403–406.

Ni B R 1997 Seed coating, film coating and pelleting. In: Chinese Assoc. of Ag. Sci., DDA, Minis. of Ag., PR China and China Nat. Seed Group Cooperation, (ED.), Seed industry and ag. Dev., Bejing, China Ag. Press. pp. 737–747

Panse V G, & Sukhatme, P V 1985 Statistical methods for agricultural research. ICAR, New Delhi, 8: 308–318.

Pariari A, Mukherjee A, & Das S 2015 Growth and yield of fennel (*Foeniculum vulgare* L.) as influenced by integrated nitrogen management and spacing. J. Crop Weed. 11(2): 90–93.

Robani, H., 1994, Film-coating horticultural seed, Hor Tech. 4: 104–104.

Singh S, Sangwan V P, Singh H, Sheoran V, Kumar S & Malik A K 2020 Effect of pelleting on seed quality of fennel (*Foeniculum vulgare*). Ind. J. Pure App. Biosci. 8(3): 162–168.

Taylor A G, Allen P S, Bennett M A, Bardford K J, Burris, J S & Misra M K 1998 Seed enhancements. Seed Sci. Res. 8: 245–256.

Taylor A G, Harman, G E & Nielsen, P A 1994 Biological seed treatments using

Trichoderma harzianum for horticultural crops. Hor Tech. 4: 105–109.

Zoubiri S, Baaliouamer A, Seba N & Chamouni N 2014 Chemical composition and larvicidal activity of Algerian *Foeniculum vulgare* seed essential oil. Arabian Journal of Chemistry. 7(4): 480–485.