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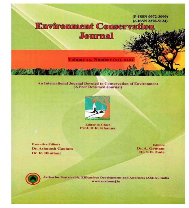

Impact of engineering properties of grass seeds in developing post-harvest operations and machineries

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ABSTRACT

Engineering properties of grass seeds are most important for the development of post-harvest mechanization and operations. Therefore engineering properties of fluffy as well as true seeds were determined in view of its important in development of post-harvest mechanization. The mean values of length, width, thickness, arithmetic mean diameter, geometric mean diameter, sphericity, surface area, volume, thousands seed mass and bulk density of fluffy Deenanath grass seed were observed in the range of 5.23-7.17 mm, 2.10-3.44 mm, 1.17-2.49 mm, 3.07- 4.13 mm, 2.53- 3.69 mm, 41.01-60.13 %, 19.12-43.70 mm^2, 3.70-18.24 mm^3, 0.789-0.849 g and 7.41-7.89 kg/m^3 respectively. However, for true seeds of Deenanath grass, the range of these values varied from 2.23-2.65 mm, 0.69-0.95 mm, 0.47-0.69 mm, 1.16-1.40 mm, 0.93-1.17 mm, 38.69-47.33 %, 2.67-4.31 mm^2, 3.60-9.64 mm^3, 0.468-0.488 g and 602.97-624.29 kg/m^3 respectively moisture level of 9 % db. Determined properties of fluffy as well as true seeds of Deenanath would be utilized to develop threshing, cleaning, grading, seed storage and packaging operations and machineries.

Introduction

Grasses belong to Poaceae (Gramineae) family, the most prominent taxa in the grasslands and also important constituents of grasslands. The grasslands and rangeland in the world occupies 70% of the world agricultural area (Zhaoli, 2004) which contributes the livelihoods of more than 800 million people, of which 45% area is in arid and semiarid grassland ecosystems (Malaviya *et al.,* 2006). More than one third of the world poorest population lives in grasslands (Nanule, 2010). The grasses provide supplementation of human food in form of meat, milk, eggs etc through intermediaries of animals. Major forage grass genera with biodiversity include Bothriochloa, Dichanthium, Cynodon, Panicum, Pennisetum, Cenchrus, Lasiurus, etc. Dinanath grass (Pennisetum pedicellatum trin) is a cultivated annual warm season grass. It is closely related to *P. atrichum, P. glacum, P. hordeoides, P. pedicellatum, P. polystachion, P. setosum* form a polyploid and agamic complex. The species is thought to be native to tropical Africa, however, widespread in West to East Africa, Asia, Africa, North America and Oceania. In India and Nepal it is found on cultivated and pasture land but it doesn't survives well under shade. It is found growing in the natural grasslands on poor and marginal soils of Bihar, Odisha, West Bengal, Madhya Pradesh, and Uttar Pradesh. Ease in planting through seeds coupled with high initial growth vigour makes the grass popular. The mature plant can also be used as a nutritive dry fodder. The major problem with dinanath grass seed is very low seed yield but high in demand (Meena and Nagar, 2019), fluffy covering seed (4-6 mm long), tiny size true seeds (Singh *et al.,* 2020). Separation of true seeds

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facilitates the coating and pelleting operation which provides uniform seed size, precision planting, more insect and disease resitant and better performance in stress conditions (Maity *et al.,* 2018) Removal of fluff and separation of quality true seeds from fluffy *Deenanath* seed is very cumbersome process. Manually it is being done by beating the dried fluffy seeds. This method seed is tedious and time consuming with less seed recovery. Traditional cotton-batting machine has been tested for the removal of fluff and hairs after several adjustment in the machine (Vijay *et al.,* 2018), but it does not serve to purpose for efficient separation of quality seed.

Several studies for processing of grass seeds and other similar seeds have been reported. Hammer mill for seca stylo seed, horizontal cone-shaped polishing chamber for dehulling of Chloris gayana , and spike cylinder type single locking cotton feeder cum cleaner for double roller gin (Arude *et al.,* 2018). A tyre type pelleting machine was developed (Maity *et al.,* 2017) and observed 91 % germination of seed pellets of dinanath grass. The engineering properties (size, shape, mass and density) play an important role in development of post harvest operations and machines viz. grading, cleaning, handling, transportation, and storage structure (Maunde *et al.,* 2007; Kibar *et al.,* 2014; Rajaiah *et al.,* 2020; Malik and Saini, 2016) . Commercial machines for postharvest operations of fluffy seeds are not available. Therefore, there is the need to study the engineering properties of dinanath fluffy seeds as well as true seeds for better post harvest processing operations.

Material and Methods

The study was conducted at ICAR–IGFRI, Jhansi, India. The physical properties of fluffy as well as true seeds of dinanath grass seeds were determined. The moisture content was determined by heated air oven method at 105±3 °C for 24 h (AOAC, 1980). Length, width, thickness, arithmetic mean diameter, geometric mean diameter, sphericity, surface area, volume, bulk density and 1000 seed mass were determined using the relationship given (Dursun and Dursun, 2005; Singh *et al.,* 2016).

The average size of fluffy dinanath seeds and true seeds of dinanath were determined by randomly selecting 100 seeds and were measured using a digital vernier caliper (Mitutoyo Corporation, Japan; Model No: CD-12'' C; least count 0.01 mm). Thousand seed mass was determined by picking the sample of thousand seeds randomly from the lot and the mass of each sample were measured on a precision electronic balance having accuracy of 0.01 g. Bulk density of seeds was measured using AOAC method, in which a 500 ml cylinder was filled with dinanath seeds to 15 cm of height and calculated as the ratio between the seed weight and the volume of the cylinder.

Measurement of Engineering Properties

The average size of Deenanath grass seeds was determined in terms of linear dimensions namely, length, width and thickness using a digital vernier caliper (Mitutoyo Corporation, Japan; Model No: CD-12'' C; least count 0.01 mm). To describe the shape of Deenanath grass seeds are sphericity (φ) was measured. The sphericity of Deenanath seeds is defined as the ratio of the surface area of the sphere having the same volume as that of the seed to the surface area of the seed (Dursun and Dursun, 2005). The thousand seed mass of Deenanath grass seeds was determined by picking the sample of thousand seeds randomly from the lot and the weight of each sample was measured on a precision electronic balance having an accuracy of 0.01 g [24] **.**The measurement was repeated five times and the average of replicated values is reported. The bulk density of Deenanath grass seeds is defined as the ratio of the mass of true seeds Deenanath grass to the total volume occupied. Bulk density (ρ_b) of seeds was measured using AOAC method, in which a 500 ml cylinder was filled with Deenanath seeds to 15 cm of height. The excess seeds were removed by sweeping the surface of the cylinder and the grains were not compressed. Bulk density was then calculated as the ratio between the seed weight and the total volume of the cylinder (Sacilik *et al.,* 2003). The average of five replications was taken as bulk density.

Results and Discussion

Evaluation of Engineering Properties

The mean values of engineering properties of fluffy and true seeds of Deenanath grass viz. length, width, thickness, arithmetic mean diameter, geometric mean diameter, sphericity, surface area, and volume at a selected level of moisture contents are presented in Table 1 respectively. The length, width and thickness of fluffy seed were considerably more than that of true seeds due to fluffy and hairy nature of Deenanath seed which covers the entire true seeds. Similar findings were found for Ajwain seeds (Zewdu, 2011). The results were in full agreement with the earlier findings for Onion seeds (Pandiselvam *et al.,* 2014), Vetch seeds (Yalcin and Ozarslan, 2004), and Hulled wheat (Unal, 2009).

The comparison between sphericity of fluffy and true seeds of Deenanath grass is depicted in Table 1, which reveals that sphericity of Deenanath fluffy seed is more than that of its true seeds but both are not spherical. These findings are in confirmation by (Aydin and Konak, 2002), for Turkish mahaleb (Dursun and Dursun, 2005) for Capper seeds**, (**Altuntas *et al.,* 2005) for fenugreek seeds and **(**Nimkar *et al.,* 2005) for Moth gram. The data on lower values of sphericity indicates that the Deenanath grass true seed will not roll easily on an inclined surface and is useful in designing the feed hoppers. The closer the sphericity value to 100%, the higher will be its tendency to roll about any of the three axes (Akaaimo and Raji, 2006). Thousand seed mass of fluffy Deenanath grass and true seeds at 9 % (db) moisture content (Table 1) clearly indicates that the mass of fluffy seed is more as compared to the mass of true seeds. Similar results have been reported by (Gharibzahedi *et al.,* 2010) for black cumin and (Singh *et al.,* 2020) for spikelets of Deenanth seed which has almost similar shape like Deenanath**.**

The experimental results for the bulk density of fluffy and true seeds of Deenanath grass at 9% moisture levels are shown in Table 1.

Table 1: Physical properties of fluffy and nucleus seeds of dinanath grass at 9% moisture content

Properties	**Mean value for fluffy seeds**	**Mean value for nucleus seeds**
Length (*L*), mm	6.20±0.97	2.44±0.21
Width (*W*), mm	2.77±0.67	0.82±0.13
Thickness (*T*), mm	1.83±0.66	0.58±0.11
Arithmetic mean dia. (D_a), mm	3.60±0.53	1.28±0.12
Geometric mean dia. (D_g), mm	3.11±0.58	1.05±0.12
Sphericity, %	50.57±9.56	43.01±4.32
Surface area (A_s), mm^2	31.41±12.29	3.49±0.82
Volume (*V*), mm^3	10.97±7.27	6.62±3.02
1000- seed mass, g	0.819±0.03	0.478±0.01
Bulk density (ρ_b), kgm^{-3}	7.65±0.24	613.63±10.66

The bulk density of fluffy Deenanath seed was found to be very less as compared to that of true seeds. The huge difference between the bulk densities of Deenanath spikelets and true seeds is due to the presence of hairy structure/fluff and void around the seeds of Deenanath fluffy grass. The decrease in the value of bulk density might be due to the higher rate of increase in volume relative to the increase in mass. These results of bulk density are in accordance with those presented for Dill seeds (Singh *et al.,* 2016) Turkish mahaleb (Aydin and Konak, 2002) and Moth gram **(**Nimkar *et al.,* 2005).

Impact of Engineering Properties on the development of post-harvest operations

The results of the dimensional values viz. length, width, thickness, arithmetic mean diameter, geometric mean diameter, sphericity, surface area, and volume would be helpful to replace manual operation of *Deenanath* seed defluffing, cleaning, conveying and handling with mechanical operation by utilizing the reported data for the development of machines and processing operations. Similar findings for sunflower seed, dill seed and ajwain seed were reported by (Munder *et al.,* 2017). The major difference in the dimensions of *Deenanath* grass seed with the other types of seed (reffered seed) is that Deenanath seed are the smallest one in the dimensions (including length, width and thickness) compared to all the referred seed. Therefore, the existing machines used for post harvest processing of other seeds could not be used for mechanical processing of *Deenanath* seed. Consequently, design and development of new machines would be possible for the processing of *Deenanath* seed based on the reported dimensional properties. The data would be used for the selection of sieve size, inclination of sieve, power required for size reduction etc. The data on relatively lower values of sphericity indicated that the true *Deenanath* seed would not rotate easily during handling, conveying, feeding in seed pelleting machine and feed hoper of different machines. This fact can be useful in designing feed hoppers, conveying systems, discharge outlet for seed processing, handling and packaging machines. The mass of any agricultural commodity is an important factor in designing air-cleaning and pneumatic conveying operations as it affects the acceleration of the seeds, thereby, influencing the aerodynamic force exerted on the particle (Solomon and Zewdu, 2009). The value of bulk density of *Deenanath* seed would help in deciding the capacity of feeding chute (hopper) of the defluffing machine, volume of packing bags, capacity of storage and transportation system, dry or process the definite quantity of *Deenanath* seeds at particular moisture content.

Conclusion

Post harvest processing operations are not standardized for fluffy grass seeds to defluff, clean and grade because of their tiny size and peculiar fluffy characteristics. Generated information on selected engineering properties of fluffy and true *Deenanath* seed would be utilized to develop suitable machine of unique design of hopper, concave clearance, discharge chute, sieve size of concave, sieve size of cleaning and grading machines, seed storage and packaging systems etc.

References

Arude, V. G., Deshmukh, S. P., Patil, P. G., & Shukla, S. K. (2018). Development of Spike Cylinder Type Single Locking Cotton Feeder cum Cleaner for Double Roller Gin. *Agricultural Engineering Today*, *42*(1), 15-19.

Association of Official Analytical Chemists, & Association of Official Agricultural Chemists (US). (1980). *Official methods of analysis* (Vol. 13).

Aydin, C., & Konak, M. (2002). PH—Postharvest Technology: Some Physical Properties of Turkish Mahaleb. *Biosystems Engineering*, *82*(2), 231-234.

Altuntaş, E., Özgöz, E., & Taşer, Ö. F. (2005). Some physical properties of fenugreek (Trigonella foenum-graceum L.) seeds. *Journal of food engineering*, *71*(1), 37-43.

Akaaimo, D. I., & Raji, A. O. (2006). Some physical and engineering properties of Prosopis africana seed. *Biosystems Engineering*, *95*(2), 197-205.

Dursun, E., & Dursun, I. (2005). Some physical properties of caper seed. *Biosystems Engineering*, *92*(2), 237-245.

Gharibzahedi, S. M. T., Mousavi, S. M., Moayedi, A., Garavand, A. T., & Alizadeh, S. M. (2010). Moisture-dependent engineering properties of black cumin (Nigella sativa L.) seed. *Agricultural Engineering International: CIGR Journal*, *12*(1).

Kibar, H., Öztürk, T., & Temizel, K. E. (2014). Effective engineering properties in the design of storage structures of postharvest dry bean grain. *Acta Scientiarum. Agronomy*, *36*, 147-158.

Maity, A., Vijay, D., Singh, S. K., & Gupta, C. K. (2017). Layered pelleting of seed with nutrient enriched soil enhances seed germination in Dinanath grass (*Pennisetum pedicellatum*). *Range Management and Agroforestry*, *38*(1), 70-75.

Maunde, F. A., Ali, M. A., El Okene, A., & Riji, B. B. (2007). Determination of physicomechanical properties of cowpeas to aid thresher design. In *Advanced Materials Research* (Vol. 18, pp. 159-164). Trans Tech Publications Ltd.

Maity, A., Vijay, D., Gupta, C. K., Singh, S. K., Wasnik, V. K., Manjunatha, N., & Ghosh, P. K. (2018). Polymer film coating mediated delivery of pesticide enhances germination, vigour and shelf life of cowpea seeds under biotic stress and natural ageing. *Range Management and Agroforestry*, *39*(2), 215-223.

Meena, S. S., & Nagar, R. P. (2019). Effect of pelleting material on seedling emergence and growth parameters in Cenchrus species. *Range Management and Agroforestry*, *40*(2), 313-317.

Malik, M. A., & Saini, C. S. (2016). Engineering properties of sunflower seed: Effect of dehulling and moisture content. *Cogent Food & Agriculture*, *2*(1).

Munder, S., Argyropoulos, D., & Müller, J. (2017). Class-based physical properties of air-classified sunflower seeds and kernels. *Biosystems Engineering*, *164*, 124-134.

Maity, A., Vijay, D., Singh, S. K., & Gupta, C. K. (2017). Layered pelleting of seed with nutrient enriched soil enhances seed germination in Dinanath grass (Pennisetum pedicellatum). *Range Management and Agroforestry*, *38*(1), 70-75.

Maunde, F. A., Ali, M. A., El Okene, A., & Riji, B. B. (2007). Determination of physicomechanical properties of cowpeas

to aid thresher design. In *Advanced Materials Research* (Vol. 18, pp. 159-164). Trans Tech Publications Ltd.

Malik, M. A., & Saini, C. S. (2016). Engineering properties of sunflower seed: Effect of dehulling and moisture content. *Cogent Food & Agriculture*, *2*(1).

Malaviya, D. R., Kaushal, P., & Kumar, B. (2006). Differential response of Guinea grass (Panicum maximum) morphotypes to shade under rainfed condition. *Range Management and Agroforestry*, *27*(2), 70-76.

Nalule, S. A. (2010). Social management of rangelands and settlement in Karamoja. *Kampala: FAO*.

Nimkar, P. M., Mandwe, D. S., & Dudhe, R. M. (2005). Physical properties of moth gram. *Biosystems Engineering*, *91*(2), 183-189.

Pandiselvam, R., Pragalyaashree, M. M., Kailappan, R., Thirupathi, V., & Krishnakumar, P. (2014). Moisture dependent engineering properties of onion seeds. *Journal of Agricultural Engineering*, *51*(2), 36-43.

Rajaiah, P., Mani, I., Parray, R. A., Lande, S. D., Kumar, A., & Vergese, C. (2020). Design and development of precision planter for Paddy direct seeding. *Journal of Agricultural Engineering*, *57*(4), 302-314.

Singh, R. K., Vishwakarma, R. K., Visha, M. K., Goswami, D., & Mehta, R. S. (2016). Moisture dependent physical properties of dill. *Journal of Agricultural Engineering* 53 .33-40.

Singh, S. K., Kautkar, S., Gurjar, B., Pathak, P. K., & Swami, S. (2020). Engineering properties of spikelets and true seeds of deenanath (Pennisetum pedicellatum Trin.) grass. *Range Management and Agroforestry*, *41*(2), 328-335.

Sacilik, K., Öztürk, R., & Keskin, R. (2003). Some physical properties of hemp seed. *Biosystems engineering*, *86*(2), 191-198.

Solomon, W. K., & Zewdu, A. D. (2009). Moisture-dependent physical properties of niger (Guizotia abyssinica Cass.) seed. *Industrial crops and products*, *29*(1), 165-170.

Ünal, H. G. (2009). Some physical and nutritional properties of hulled wheat. *Journal of Agricultural Sciences*, *15*(1), 58-64.

Vijay, D., Gupta, C. K., & Malaviya, D. R. (2018). Innovative technologies for quality seed production and vegetative multiplication in forage grasses. *Current Science*, *114*(1), 148.

Yalçın, İ., & Özarslan, C. (2004). Physical properties of vetch seed. *Biosystems Engineering*, *88*(4), 507-512.

Zhaoli, Y. (2004). 'Co-Management of Rangelands: An Approach for Enhanced Livelihood and Conservation. *ICIMOD Newsletter*, *45*, 15-17.

Zewdu, A. D. (2011). Moisture-dependent physical properties of ajwain (Trachyspermum ammi L.) seeds. *Philippine Agricultural Scientist*, *94*(3), 278-284.