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Moisture Dependent Physical Properties Assessment of Deenanath Grass Seeds

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ABSTRACT

A study was conducted to assess the effect of moisture content at five levels varying from 6.88 to 19.23 % (dry basis) on selected physical properties of defluffed Deenanath grass seeds. The physical properties viz. length, width, thickness, arithmetic mean diameter and geometric mean diameter of defluffed Deenanath seeds increased from 2.30 to 2.56 mm, 0.71 to 0.96 mm, 0.47 to 0.63 mm, 1.16 to 1.38 mm and 0.90 to 1.15 mm respectively with increase in moisture content whereas, the bulk density, true density, and porosity decreased from 652.16 to 585.78 $kg.m^{-3}$, 852.63 to 792.71 $kg.m^{-3}$ and 25.62 to 24.97% respectively with an increase in moisture content in the selected range of 6.88 to 19.23%. The study showed that the aspect ratio, sphericity, surface area, volume and thousand seed mass of defluffed Deenanath seeds were in the range of 30.91 to 37.51 %, 0.39 to 0.45, 2.58 to 3.23 mm^2, 3.71 to 4.97 mm^3 and 0.480 to 0.523 g respectively.

Key words: *Physical properties, Deenanath, Moisture*

Introduction

Deenanath grass is having high importance under drought and marginal soil, nutritional security in animals and by providing high quantum of quality forage, soil erosion control and as a bio-energy crop (Kumar and Ghosh, 2018). The grass has the potential to be used as source of some important nutrients in alleviating macro and micro-nutrients deficiencies in animals (Mustapha *et al.* 2018). *Pennisetum pedicellatum* is a profusely tillering annual with high leaf/ stem ratio and low oxalate content. Potential of green fodder yield (GFY) varied from 30.0-48.0t/ha and dry matter yield (DMY) varied from 6.0-6.8t/ha (Ahmed *et al.,* 2017).

The spikelet is about 4-6 mm long usually solitary, falls at maturity with bristles, comes in clusters of 1-5 and forms a fluffy ovate involucre 0.5-1 cm in length. Seed yield of grasses are very low, while demand for seed is high for rejuvenation of grasslands. Germination of fluffy grass seeds are also less (<40%). The light weighed and small sized seed leads to difficulties in handling, transportation and precise sowing in the field. Separation of fluffs and hairs from fluffy Deenanath grass seed which contains 2-3 nucleus seeds is difficult due to their minute size. It is separated manually by beating the fluffy Deenanath grass seeds with a wooden rod, to get defluffed seed. Defluffed (without fluff and hair) deenanath seeds are preferred for sowing in the field after making pellets (seed balls), over the hairy grass seeds for rejuvenating the denuded grasslands (Vijay *et al.,* 2018). Traditional method (manual) of defluffing Deenanath grass seed is time consuming, labour intensive and includes foreign materials in the defluffed seed. Several advances have been made in processing of cereals, pulses, oilseeds, fruits and vegetables, but hardly, any equipment is used in defluffing, cleaning and separation of fluffs and hairs from fluffy grass seeds. Defluffed seeds are sold @ Rs. 5500 per kg by government institutions and purchased by state forest departments, dairy industries and animal rearing farmers. Potential exists for developing handling and processing equipments for Deenanath grass seeds (Singh *et al*., 2020). Maity *et al*., (2018) worked on the coating technology of forage seeds. Knowledge of physical properties of a crop is essential for proper design of processing equipment.The present investigation, therefore, aimed at determining the moisture dependent physical properties of defluffed Deenanath grass seeds.

Materials and Methods

The spikelets of Deenanath grass seeds were defluffed (removal of fluff and hairs) manually to extract defluffed (true seeds) by beating it with 1-2 meter of the wooden rodon threshing floor and then sieving. After defluffing, the mixture of true seeds along with other foreign materials were subjected to cleaning using different hand test sieves of different sizes viz. 1.18 mm and 0.60 mm (square hole) in the laboratory of ICAR – IGFRI Jhansi. The seeds retained over 0.60 mm sieve were the required true seeds. The sample seeds (defluffed, i.e. true seed) of Deenanath grass were randomly selected and investigated in terms of moisture dependent physical properties.

The initial moisture content of defluffed Deenanath seed was determined using standard oven method in three replications by keeping the seeds at 105 °C ± 1 °C for 24 h. The initial moisture content of the seed was 10.21% (d.b.). Physical properties of defluffed Deenanath seed were assessed at moisture levels of 6.88, 10.21, 12.77, 16.19 and 19.23% (d.b.). The initial moisture of 6.88 % (d.b.) selected for the experimentation was obtained by drying the true seed samples in hot air oven till constant weight is achieved. The remaining levels of moisture content of test samples was achieved by incorporating the measured quantity of distilled water based on following equation (Dursun and Dursun, 2005), followed by proper mixing and packing in low-density polyethylene (LDPE) bags.

The LDPE bags with conditioned samples were stored at 4-7 ºC in a refrigerator for 7 days for moisture to distribute uniformly throughout the sample (De Figueiredo *et al.*, 2011). The required quantity of defluffed Deenanath seed was taken out from the refrigerator and kept at room temperature (28-35 ºC) for 2 h before conducting different tests (Singh *et al.*, 2016). The experimental parameters were determined by taking 100 observations randomly at each moisture level and the average values with the standard error were recorded. However, the experiments replicated five times to determine the values of thousand seed mass, bulk density, true density and porosity.

Geometrical Properties

The average size of defluffed Deenanath seed 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). The arithmetic mean diameter and geometric mean diameter of defluffed Deenanath seed were calculated by the equations used by Konak *et al*., 2002. The measurement was repeated 100 times and the average values were taken as diameter.

The volume (V) and surface area (A_s) of Deenanath seeds were calculated using equations given by Singh *et al*., 2016.

Shape: The criteria used to describe the shape of seed area sphericity and aspect ratio. The sphericity of defluffed 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. It was determined using equation used by Dursun and Dursun, 2005.

Thousand Seed Mass: The thousand seed mass of defluffed Deenanath 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 (Baryeh and Mangope, 2003 and Selvi *et al.*, 2006). The measurement was repeated five times and the average of replicated values is reported.

Bold Density: The defluffed Deenanath seed sample was filled in a 500 ml measuring cylinder upto a height of 15 cm. The excess seeds were removed by sweeping the surface of the cylinder and the grains were not compressed. Thereafter, the samples were weighed with an electronic balance. The average of five replications was taken as bulk density. Bulk density of the defluffed Deenanath seed was determined using the equation of Sharma *et al.*, 2013.

True Density: It was determined using toluene displacement technique. Weighed quantities of defluffed Deenanath grass seeds were poured into the measuring cylinder containing toluene, and the difference in the level of toluene before pouring and after pouring of defluffed Deenanath grass seeds gave the volume of toluene displaced with the seeds. The true density was calculated using equation (Dursun and Dursun, 2005).

Porosity: Porosity is the ratio of the volume of the pores to the total volume. Porosity of defluffed Deenanath seedwas determinedat various moisture contents from the calculated values of true density and bulk density with the use of the equation (Pandiselvam *et al.*, 2014).

Statistical Analysis

The data of recorded parameters were statistically analyzed using SAS statistical software at a given range of moisture contents. The differences between the mean values of the physical properties of defluffed Deenanath seed samples were tested for significance using t-test.

Results and Discussion

Geometrical properties

The axial dimensions viz. length, width, thickness, arithmetic mean diameter and geometric mean diameter increased significantly ($p<0.05$) with increase in moisture content in the range of 6.88 to 19.23% (d.b). The dimensional increase in length, width and thickness were 11.30, 35.21 and 34.04% respectively with respect to the initial value of moisture content. The trend of increased axial dimensions of defluffed Deenanath seeds against moisture content is depicted in Fig. 2. The Deenanath seeds expand more along its width and thickness in comparison with its length. This behavior was also reported by Singh *et al.* (2016) for Dill seeds. This linear increase in all the dimensions of seed samples is due to the expansion resulting from moisture absorption by the sample seeds in their intercellular space. The increase in the moisture content of the seeds suggests that the drying of defluffed Deenanath seeds would results in shrinkage due to a decrease in seed dimensions. Similar findings for Sunflower seeds and Dill seeds were reported by Munder *et al.* (2017) and Singh *et al.* (2016) respectively.

The average diameters calculated in terms of arithmetic mean diameter and geometric mean diameter were varied from 1.16 to 1.38 mm and 0.90 to 1.15 mm respectively in the experimental range of moisture content. The volume and surface area of Deenanath grass seeds were also increased significantly with increase in moisture content. The percent increase in volume was found to be 33.96 % whereas the surface area was increased by 25.19 % with respect to the initial value of moisture content. The ANOVA (analysis of variance) indicates that the differences among diameters of Deenanath grass seeds, volume, and surface area were significant at 0.05% level of significance. In other words, the geometrical parameters were significantly different for the entire moisture range from 6.88 to 19.23% (d.b.). The results were in full agreement with the earlier findings for Caper seeds (Dursun and Dursun, 2005), and Onion seeds (Pandiselvam *et al.*, 2014).

Shape

The data on linear dimensions and the major axis of the seeds were used for calculation of sphericity and aspect ratio and the results obtained are presented in Fig. 3 and Fig. 4 respectively. The sphericity of the defluffed Deenanath seeds increased from 0.39 to 0.45 and aspect ratio varied from 30.91 to 37.51% when the moisture content increased from 6.88to 19.23% (d.b.). Sphericity displayed significant differences with change in moisture content of the seed. The increase in sphericity might have been caused by a proportional increase in the width and thickness of the seed with increase in moisture content. Similar findings have been reported by Dursun and

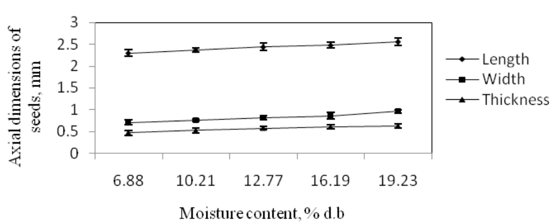

Fig. 2. Effect of moisture content on axial dimensions

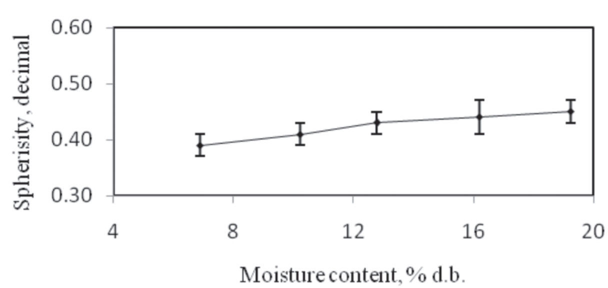

Fig. 3. Effect of moisture content on sphericity

Dursun (2005) for Capper seeds. The data on relatively lower values of sphericity (0.39 to 0.45%) indicates that the defluffed Deenanath seed will not rotate easily during handling, feeding into seed pelleting machine and packaging.

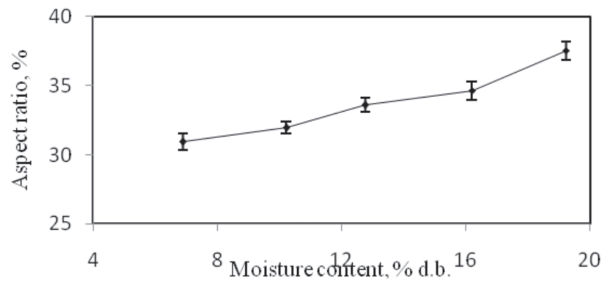

Fig. 4. Effect of moisture content on aspect ratio

Thousand seed mass

The experimental values obtained for thousand seed mass of defluffed Deenanath seeds in relation to its moisture content are shown graphically in Fig. 5. The thousand seed mass significantly ($p < 0.05$) increased from 0.480 to 0.523 g with the corresponding increase in moisture content from 6.88 to 19.23% (d.b.) which could be the result of added moisture. 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).

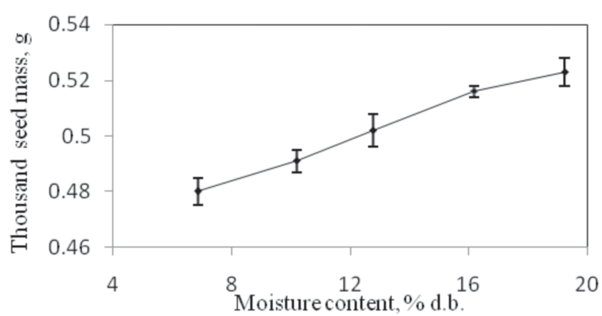

Fig. 5. Effect of moisture content on thousand seed mass

Bulk density

The experimental results for the bulk density of defluffed Deenanath seeds at various moisture levels are shown in Fig. 6. The bulk density was found to decrease linearly from 652.16 to 585.78 kg.m^{-3} as moisture content increased from 6.88% to 19.23% (d.b.). This decrease in the value of bulk density might be due to the higher rate of increase in volume relative to the increase in mass. This would cause the effect of greater compaction in dry seeds compared to wet seeds. These results of bulk density are in accordance with those presented for dill seeds (Singh *et al.*, 2016).

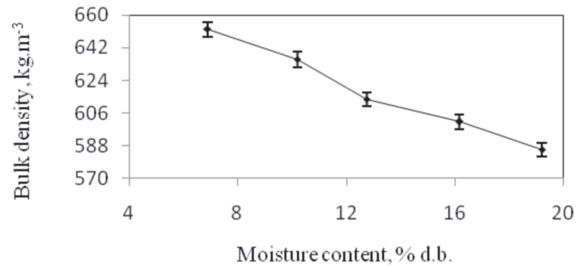

Fig. 6. Effect of moisture content on bulk density

True density

The true density of defluffed Deenanath seeds decreased from 852.63 to 792.71 kg.m^{-3} with an increase in moisture content from 6.88 to 19.23%d.b. (Fig. 7). This decrease in the value of true density might be due to a significant increase in volume, which was higher than the corresponding increase in the mass of the seeds. Different types of variation in the trend of true density with moisture content for various agricultural seeds have been reported by many researchers. An increase in true density with moisture content has been reported by De Figueiredo *et al.*, (2011) for Sunflower seeds. The true density of defluffed Deenanath seeds was higher than that of its bulk density at a given range of moisture contents.

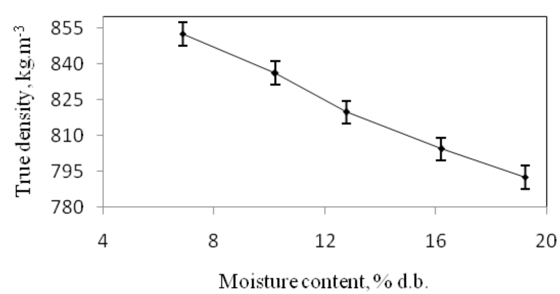

Fig. 7. Effect of moisture content on true density

Porosity

The porosity of defluffed Deenanath seeds obtained from experimental data decreased from 25.62 to

24.97% as the moisture content increased from 6.88 to 19.23% d.b. (Fig. 8). The trend of decrease in porosity with an increase in moisture content has been earlier reported by Singh *et al.* (2016) for dill seeds.

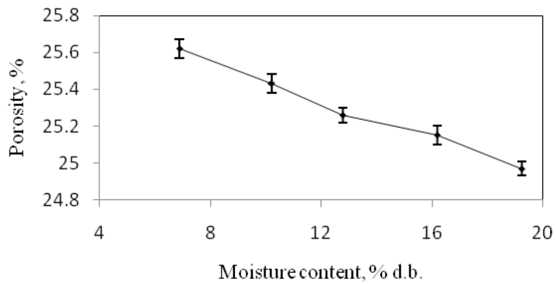

Fig. 8. Effect of moisture content on porosity

Conclusion

The average length, width, thickness, geometric mean diameter and arithmetic mean diameter of the defluffed Deenanath seeds increased linearly from 2.30 to 2.56, 0.71 to 0.96, 0.47 to 0.63, 1.16 to 1.38 and 0.90 to 1.15 mm respectively, with a corresponding increase in moisture content from 6.88 to 19.23% (d.b.). Similar trend was shown for sphericity of defluffed Deenanath seeds which increased from 0.39 to 0.45% with an increase in the moisture content in the experimental range. The aspect ratio, volume, surface area, and thousand seed mass of defluffed Deenanath seeds were linearly varied from 30.91 to 37.51%, 3.71 to 4.97 mm^3, 2.58 to 3.23 mm^2, 0.480 to 0.523 g respectively. However, bulk density and true density decreased linearly from 652.16 to 585.78 $kg.m^{-3}$ and 852.63 to 792.71 $kg.m^{-3}$ respectively in the specified moisture range.The porosity of defluffed Deenanath seeds decreased from 25.62 to 24.97%, linearly with an increase in the selected range of moisture content.

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