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Physical Properties of Hungarian and Common Vetch Seeds

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Abstract: The physical properties of Hungarian and common vetch seeds were determined at moisture content of 11.57 and 10.3% d.b., respectively. The mean values of length, width, thickness and geometric mean diameter were 4.27, 4.03, 3.38, 3.86 mm, respectively for Hungarian vetch seed and were 5.11, 4.49, 3.83, 4.44 mm, respectively for common vetch seed. One hundred seed weights of Hungarian and common vetch seed were 4.33 and 5.88 g, respectively. The mean sphericity value was obtained as 0.91 for Hungarian vetch seed and as 0.87 for common vetch seed. The mean bulk and true densities were 772.17, 1205.81 kg m^{-3}, respectively for Hungarian vetch seed and were 785.9, 1091.19 kg m^{-3}, respectively for common vetch seed. The angles of repose of Hungarian and common vetch seed were 13.64° and 12.95°, respectively. The values of coefficient of dynamic friction against hard-wood sheet, galvanized steel, mild steel, chipboard and rubber surfaces were 0.29, 0.30, 0.33, 0.33, 0.41, respectively for Hungarian vetch seed and were 0.27, 0.27, 0.31, 0.31, 0.45, respectively for common vetch seed; while the values of coefficient of static friction were 0.35, 0.36, 0.39, 0.43 and 0.45, respectively for Hungarian vetch seed and were 0.32, 0.34, 0.39, 0.45, 0.48, respectively for common vetch seed.

Key words: Physical properties, Hungarian vetch seed, common vetch seed

INTRODUCTION

Hungarian vetch (*Vicia pannonica* Crantz) and common vetch (*Vicia sativa* L.) are adapted to the environments of large areas of Turkey and grown generally as a winter annuals. Vetch species are grown for green herbage, hay and seed production and can be used successfully in ruminant feeds and feed rations[1]. Hungarian vetch is one of the promising vetch species and is resistant to the winter conditions of Central Anotolian region[2] and common vetch is suitable in some of areas with mild winters especially coastal and foothill areas in Turkey. The total vetch sown areas was approximately 233000 ha and total production was 340000 t of green forage and 130000 t seed in Turkey[3]. Physical properties of Hungarian and common vetch seeds are to be known; for design and improve of relevant machines and facilities for handling, storing, harvesting and processing. The size and shape are important in designing of separating, sizing and granding machines. Bulk density and porosity affect the structural loads, resistance to airflow of the stored mass and are important parameters in designing of drying and storing systems. The angle of repose is important in designing of storage and transporting structures. The coefficient of friction of seed against the various surfaces is also necessary in designing of conveying, transporting and storing structures.

The specific objectives of this study were to determine some of the physical properties of Hungarian and common vetch seed such as; linear dimensions, 100-seed weight, geometric mean diameter, sphericity, bulk density, true density, repose angle, porosity and coefficient of static and dynamic friction against different materials.

MATERIALS AND METHODS

Hungarian vetch (*Vicia pannonica* Crantz) and common vetch (*Vicia sativa* L.) were used in the study were obtained from a local market in Tokat, Turkey. Seeds were cleaned with air effect and manually to remove all foreign matter, broken and immature seeds. The moisture content of the samples was determined by oven drying at 105+1°C for 24 h[4]. Each of the samples was replicated three times and the mean moisture content of Hungarian and common vetch seed was found as 11.57 and 10.3% (d.b.), respectively.

To determine the seed size; one hundred seeds were randomly selected and length, width, thickness were measured using a dial-micrometer with a reading accuracy of 0.01 mm. The geometric mean diameter (Dg) and

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sphericity (ϕ) of seeds were calculated using the equation formula given by Mohsenin[5] as follows:

$$Dg = (LWT)^{0.333} \quad (1)$$

$$\phi = (LWT)^{0.333} L^{-1} \quad (2)$$

Where, L is the grain length, W the grain width and T is the grain thickness.

To obtain the 100-seed weight; 1000 seeds were randomly selected from the bulk, divided in 10 groups and weighed by an electronic balance weighing to an accuracy of 0.001g.

The bulk density (ρ_b) was determined with a weight per hectoliter tester, which was calibrated in kg per hectoliter[4-7].

We determined the seed volume and its true density (ρ_t) using the liquid displacement method. Toluene was preferred rather than water, because it is absorbed with seeds to a lesser extent. We determined the volume of liquid displaced using immersing a weighed quantity of seeds in the liquid[7-10].

The porosity ε of bulk seed was calculated from bulk and true densities using the equation given by Mohsenin[5] as follows:

$$\varepsilon = (1-\rho_b / \rho_t)x100 \quad (3)$$

In order to determine the angle of repose; topless and bottomless cylinder with 30 cm diameter and 50 cm height was used. The cylinder was placed at the center of a circular plate and was filled with seed. The cylinder was raised slowly so that a natural heap was formed. The angle of repose of seeds was calculated from the diameter and height of a heap on a circular plate[11].

The coefficient of friction was measured using a friction device. The device consists of metal box, friction surface and electronic unit, which covers mechanical force unit, electronic variator, load cell, electronic ADC card and PC. The load cell is connected to the metal box with iron bar. Top and bottom line open metal box is sized 30x30x30 cm^3. For the measuring of friction force, friction surface (hard-wood sheet, galvanized steel, mild steel, chipboard and rubber) is moved horizontally by the stationary velocity of 0.02 m s^{-1}. Friction force values are measured by load cell, converted by ADC card and converted data is recorded in computer[12]. The maximum obtained value was used to calculate the coefficient of static friction and mean value was used to calculate the coefficient of dynamic friction for each experiment.

RESULTS AND DISCUSSION

The length of the Hungarian vetch seeds ranged from 3.50 to 5.33 mm, the width ranged from 3.28 to 4.75 mm, while the thickness ranged from 2.36 to 4.18 mm. The

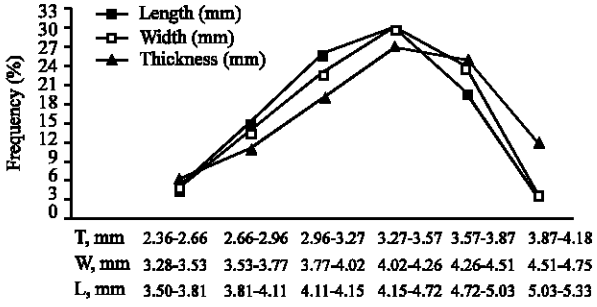

Fig. 1: Frequency distribution curves of Hungarian vetch seed dimensions at a moisture content of 11.57% d.b

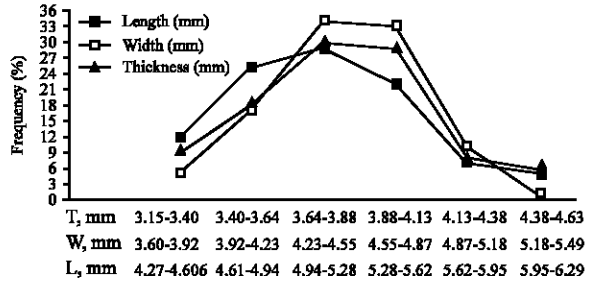

Fig. 2: Frequency distribution curves of common vetch seed dimensions at a moisture content of 10.3% d.b

length of the common vetch seeds ranged from 4.27 to 6.29 mm, the width ranged from 3.60 to 5.49 mm, while the thickness ranged from 3.15 to 4.63 mm (Fig. 1 and 2). The above parameters would be an important consideration in the development of sizing and grading machines and in their separation from undesirable materials. The geometric mean diameter was 3.86 mm for Hungarian vetch seeds and as 4.44 mm for common vetch seeds. The Hungarian vetch seed is thus smaller than the common vetch seed. The sphericity value of Hungarian vetch seed and common vetch seed was found to range from 0.75 to 0.99 and 0.75 to 0.96, respectively. This characteristic shows that the spherical shape is enables the seeds rolling rather than sliding. The mean weight of 100-seed of Hungarian vetch seed and common vetch seeds were found to be 4.33 and 5.88 g, respectively. The bulk and true density were changed between 760.59-783.54 kg m^{-3}; 1042.95-1400.39 kg m^{-3}, respectively for Hungarian vetch seed and between 779.27-792.79 kg m^{-3}; 1046.39-1155.35 kg m^{-3}, respectively for common vetch seed (Table 1). Similar bulk density result is also reported with ASAE Standarts[13] as 772 kg m^{-3} for vetch seed. The true density indicates that seeds are heavier than water and this characteristics can be used to design separation or cleaning process. The mean angles of repose of

Table 1: Some physical properties of Hungarian and common vetch at a moisture content of 11.57 and 10.3% (d.b.), respectively

	Values			
Physical properties	Mean	Maximum	Minimum	SD
Hungarian vetch				
Length L (mm)	4.27	5.33	3.50	0.38
Width W (mm)	4.03	4.75	3.28	0.28
Thickness T (mm)	3.38	4.18	2.36	0.41
Geometric mean diameter Dg (mm)	3.86	4.47	3.24	0.26
Sphericity (ϕ)	0.91	0.99	0.75	0.047
100-seed weight (g)	4.33	4.16	4.45	0.11
Bulk density ρ_b (kg m^{-3})	772.17	783.54	760.59	0.009
True density ρ_t (kg m^{-3})	1205.81	1400.39	1042.95	180.81
Angle of repose (°)	13.64	14.34	12.53	0.97
Porosity (%)	35.96	44.05	27.07	6.28
Coefficient of friction on				
Hard-wood sheet	0.29	0.35	0.24	0.02
Galvanized sheel	0.30	0.36	0.27	0.02
Mild steel	0.33	0.39	0.28	0.02
Chipboard	0.33	0.43	0.24	0.03
Rubber	0.41	0.45	0.38	0.02
Common vetch				
Length L (mm)	5.11	6.29	4.27	0.434
Width W (mm)	4.49	5.49	3.60	0.323
Thickness T (mm)	3.83	4.63	3.15	0.325
Geometric mean diameter Dg (mm)	4.44	5.19	3.76	0.05
Sphericity (ϕ)	0.87	0.96	0.75	0.047
100-seed weight (g)	5.88	6.15	5.78	0.24
Bulk density ρ_b (kg m^{-3})	785.92	792.79	779.27	6.76
True density ρ_t (kg m^{-3})	1091.19	1155.35	1046.39	57.00
Angle of repose (°)	12.95	14.18	12.13	0.90
Porosity (%)	27.97	31.38	25.51	2.24
Coefficient of friction on				
Hard-wood sheet	0.27	0.32	0.20	0.02
Galvanized sheel	0.27	0.34	0.22	0.03
Mild steel	0.31	0.39	0.24	0.03
Chipboard	0.31	0.45	0.23	0.05
Rubber	0.45	0.48	0.39	0.03

Hungarian and common vetch seeds were 13.64° and 12.95°, respectively. This is the result of the spherical shape of the seeds, which enables seeds rolling. These values are considerably lower than those reported for sesame seed as 32° by Tunde *et al.*[14]; for locust bean seed as 20.32° by Ogunjimi *et al.*[8]; for arecanut kernels as 17.69° by Kaleemullah and Gunasekar[11]. The values of coefficient of dynamic friction against hard-wood sheet, galvanized steel, mild steel, chipboard and rubber surfaces were 0.29, 0.30, 0.33, 0.33 and 0.41, respectively for Hungarian vetch seed and were 0.27, 0.27, 0.31, 0.31 and 0.45, respectively for common vetch seed; while the values of static coefficient of friction were 0.35, 0.36, 0.39, 0.43 and 0.45, respectively for Hungarian vetch seed and were 0.32, 0.34, 0.39, 0.45 and 0.48, respectively for common vetch seed. The frequency distributions of seed dimensions are shown in Fig. 1 and 2.

CONCLUSION

- The mean length, width, thickness and geometric mean diameter were 4.27, 4.03, 3.38 and 3.86 mm, respectively for Hungarian vetch seed and 5.11, 4.49, 3.83 and 4.44 mm, respectively for common vetch seed.
- The mean sphericity was as high as 0.91 for Hungarian vetch seed and 0.87 for common vetch seed, which indicates that seeds can roll rather than slide.
- The mean weight of 100-seed of Hungarian and common vetch seeds were 4.33, 5.88 g, respectively.
- The mean bulk and true density were 772.17, 1205.81 kg m^{-3}, respectively for Hungarian vetch seed and 785.92, 1091.19 kg m^{-3}, respectively for common vetch seed, which indicates that seeds are heavier than water.
- The mean angle of repose occurred 13.64° for Hungarian vetch seed and 12.95° for common vetch seed.
- The lowest coefficient of friction values were obtained from against hard-wood sheet and galvanized steel surfaces and the highest values from against the rubber surface. The coefficient of dynamic friction mean values changed from 0.29 to 0.41 for Hungarian seed and changed from 0.27 to 0.45 for common vetch seed, while the coefficient of static friction mean values changed from 0.35 to 0.45 for Hungarian vetch seed and changed from 0.32 to 0.48 for common vetch seed.

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