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Engineering properties of basmati-370

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Abstract
The knowledge about morphological and engineering properties of an agricultural grain is important in order to develop different parts of farm machinery. The understanding of these properties also proves useful in developing an ergonomically fit machine. In the present study, some of the engineering properties such as size, volume, surface area, angle of repose, porosity, etc. of raw paddy (variety Basmati-370) are discussed briefly. At moisture content of 13-16 % (w.b.), the average grain length, width and thickness were 9.55, 2.05 and 1.89 mm respectively. The sphericity and aspect ratio were 34.93 and 0.22 %, respectively.

Keywords: Paddy, basmati-370, engineering properties

Introduction
Paddy is one of the oldest known crops to have been cultivated by human. In India, paddy occupies about 43.86 million hectares, which is nearly 40 per cent of the total cereals. India with the highest area under the crop is the second largest producer of rice in the world after China but ranks 35th with respect to its productivity. More than 90 per cent of the world's production of rice comes from China and India.

Rice is cultivated in almost all the states of India, but most of its cultivation is concentrated in the river valleys, deltas of rivers and coastal plains. The major rice producing states in India are West Bengal, Uttar Pradesh, Arunachal Pradesh, Punjab and Orissa with a production of 14.71, 12.22, 11.57, 11.11, 8.29 million tons respectively. In the state of J&K, the total rice yield in 2014-15 was 1710 kg ha-1 and the total area under high yielding varieties of rice in J&K was 65 thousand ha

The different varieties of paddy that are cultivated in Jammu province of Jammu and Kashmir Union territory are IET 1410, Ratna, Tawi (PC-19), SJR-5, Jaya, PR-113, RR-8585 KHR-2 (Hybrid), PHB-71 (Hybrid), China-1039, K-39 (SKAU-5) and Basmati varieties which are Basmati-370, Basmati-564, Ranbir Basmati, Saanwal Basmati, PRH-10 (Basmati hybrid) and Pusa 1121. Among these varieties, Basmati rice (*Oryza sativa*) has tremendous export potential and has been listed under ten agricultural commodities for sustainable export promotion and planning a consistent policy for the export of the same in a report given by the ministry of commerce.

Basmati Rice is highly Basmati Rice is highly flavoured variety of superfine paddy grown in Sub-tropical area of the state namely R.S. Pura, Bishnah, Jammu, Akhnoor, Samba, Hiranagar and Kathua Tehsils of Jammu Division. Local Basmati & Basmati 370 are the most popular varieties grown in the said areas of the Union territory and are known for their cooking quality and scented nature. These varieties have a great potential for export. In Jammu & Kashmir, the total basmati area has been 68,450 ha. Out of which, Pusa Basmati-1121 has 6,290 ha and Basmati-370, 59,970 ha. The estimated production of Pusa Basmati-1121 and Basmati 370 are likely 22,330 metric tons and 2,10,440 metric tons respectively. (APEDA, 2014) [3].

As population increases, so does the pressure for intensification of agriculture. Intensification is always associated with greater requirements for labour or power or both. When demand for additional power rises above the level that the agricultural labour force is capable of providing, animal drawn implements supplement or replace hand cultivation. Similarly, when animal draft power and human labour are not capable of meeting the power demands, mechanical power sources supplement or replace these animate sources of power. The design of such machinery is greatly affected by the physical and engineering properties of the plant as the

farm machinery has to work in constant physical connection with agricultural plants.

Material and Methods

The development and evaluation of agricultural machinery is greatly affected by the physical and engineering properties of plant for which it is developed. The properties like size, volume, surface area, thousand grain weight, density, porosity, angle of repose and coefficient of friction are of prime importance while designing and developing the machine (Varnamkhasti *et al*., 2007) [4]. The engineering properties of the Basmati-370 variety of paddy crop that were studied are presented below:

Physical properties of paddy (Basmati-370)

The physical properties like dimensions, shape (sphericity), size, thousand grain weight, bulk density, true density and porosity were determined as per the standard procedure. The details are given as under:

Dimensions

A sample of 100 kernels were randomly selected and the dimensions of paddy grain such as length (L), width (W) and thickness (T) were measured in millimetre with the help of a digital vernier caliper having a least count of 10-5 mm.

Equivalent diameter

The equivalent diameter (D) in mm was calculated through the following expression (Mohsenin, 1986) [5]

$$D = \left[4L\left(\frac{W+T}{4}\right)^2\right]^{\frac{1}{3}}$$

Where, L = length of the grain, mm
W = width of the grain, mm
T = thickness of the grain, mm

Surface area and volume

The volume (V) and surface area (S) of paddy grains were calculated by using the following relationship (Pandiselvam and Venkatachalam, 2014) [6]

$$V = 0.25\left[\left(\frac{\pi}{6}\right)L(W+T)^2\right]$$

$$S = \frac{\pi BL^2}{2L - B}$$

Where, $B = \sqrt{WT}$

Aspect ratio

The aspect ratio (Ra) was used for classification of paddy shape and it was calculated as

$$Ra = \frac{W}{L}$$ (Pandiselvam and Venkatachalam, 2014) [6]

Shape

Shape of paddy can be expressed in the terms of sphericity (Ø). It is defined as the ratio or the surface area of sphere having the same volume as that of the paddy to the surface area of the paddy (Pandiselvam and Venkatachalam, 2014) [6]. Sphericity was calculated by the formula given by Mohsenin, 1986 [5].

$$\emptyset = \frac{(LWT)^{\frac{1}{3}}}{L}$$

Where, L = length of the grain, mm
W = width of the grain, mm
T = thickness of the grain, mm

Mass

Mass (M) of individual seeds was measured by using a digital scale with a least count of 10^{-4} gram.

Bulk density

The bulk density is the ratio of mass of the paddy to its total (bulk) volume. It was determined by filling a circular container of known volume with paddy (Pandiselvam and Venkatachalam, 2014) [6].

$$Pb = \frac{M}{V}$$

Where, ρb - bulk density, kg·m^{-3}
M - mass of the paddy sample, kg
V - volume of container, m^3

True density

The true density (ρt) is the ratio of mass of the paddy to its true volume. It was determined using Toluene displacement method. Toluene (C_7H_8) was used in place of water because paddy absorbed toluene to a lesser extent.

Porosity

The porosity (ε) of the paddy is the ratio of the volume of internal pores in between the paddy to its bulk volume (Pandiselvam and Venkatachalam, 2014) [6]. Porosity was calculated using the formula (Mohsenin, 1986) [5]

$$\epsilon = \frac{\rho_t - \rho_b}{\rho t} \text{ x } 100$$

Where, ϵ - porosity, %
ρb - bulk density, kg·m-^{3}
ρt - true density, kg·m-^{3}

Moisture content of grain

The initial moisture content of the paddy was determined using hot air oven at 130 °C for 14-16 h (AOAC, 1995).

$$\text{Moisture content of grains} = \frac{(W_1 - W_2)}{(W_1 - W_3)} \text{ x100}$$

Where, W_1 = Weight of the wet sample, g
W_2 = Weight of the dry sample, g
W_3 = Weight of the tray, g

Angle of repose

The angle of repose for grain was calculated by the method suggested by Waziri and Mittal (1983) [7]. The grain was heaped over a circular disc of known diameter (say 200 mm) by allowing them to fall from a known height until maximum height was reached. The experiment was replicated ten times with different known heights and the reading was taken. The following relationship was used to determine the angle of repose.

$$\theta = \tan^{-1}\left(\frac{h}{r}\right)$$

Where, θ = angle of repose, degree
h = height of the cone, mm
r = radius of the disc, mm.

Results and Discussions

The paddy grain was hard, rough and light brown in colour at the time of harvesting/maturity. The number of grains per plant was calculated for the harvested paddy plants. It was found that on an average there were about 73 grains per paddy plant. The various engineering properties of paddy like length, width, thickness, equivalent diameter, volume surface area, aspect ratio, sphericity, thousand grain weight, angle of repose, true density, bulk density and porosity were calculated at the moisture content of 13-16 % (w.b.) and are presented in Table 1.

Table 1: Engineering properties of basmati-370 grain

S. No.	Engineering property	Maximum	Minimum	Mean
1.	Length (mm)	10.26	8.58	9.55
2.	Width (mm)	2.25	1.86	2.05
3.	Thickness (mm)	2.00	1.77	1.89
4.	Equivalent Diameter (mm)	3.51	3.14	3.33
5.	Volume (mm^3)	22.71	16.28	19.44
6.	Surface Area (mm^2)	36.40	29.14	32.93
7.	Aspect Ratio	0.24	0.19	0.22
8.	Sphericity (%)	37.32	32.88	34.93
9.	Thousand Grain Weight (g)	25.22	21.12	23.41
10.	Angle of Repose (degree)	31.12	29.79	30.58
11.	True Density (gmL^{-1})			1.28
12.	Bulk Density (gmL^{-1})			0.68
13.	Porosity (%)			46.49

Conclusions

Basmati 370 is one of the most popular varieties grown in the Jammu division of Jammu and Kashmir and is known for its cooking quality and scented nature. The engineering properties such as length, width, thickness, equivalent diameter, volume surface area, aspect ratio, sphericity, thousand grain weight, angle of repose, true density, bulk density and porosity of Basmati-370 were calculated in the study. The study concluded that at moisture content of 13-16% (w.b.), the average grain length, width, thickness, sphericity and aspect ratio were 9.55 mm, 2.05 mm, 1.89 mm, 34.93 and 0.22% respectively.

References

1. DES. Statistical Digest of Jammu and Kashmir. Directorate of Economic & Statistics. Government of Jammu and Kashmir 2015.
2. FAO (Food and Agriculture Organization of the United Nations). Conservation Agriculture Website 2014. Available online at http://www.fao.org/ag/ca/
3. APEDA. Ministry of Commerce & Industry, Government of India 2014.
4. Varnamkhasti MG, Mobli H, Jafari A, Rafiee S, Heidarysoltanabadi M, Kheiralipour K. Some Engineering Properties of Paddy (var. Sazandegi). International Journal of Agriculture & Biology 2007;9(5):763-766.
5. Mohsenin NN. Physical Properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York 1986.
6. Pandiselvam R, Venkatachalam T. Important engineering properties of paddy. Scientific Journal of Agril. Engg 2014;4:73-83.
7. Waziri AN, Mittal JP. Design related physical properties of selected agriculture products. Agric. Mech. Asia Afr. Lat. Am 1983;14(1):59-62.