Some Physical Properties of Paddy grown in Konkan Region

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Abstract

Physical properties of paddy are necessary for the design of equipment to handle, transport, process and store of the crop. These properties are evaluated as a function of moisture content of grain. In this study, some physical properties of raw paddy are discussed briefly. The grain was tested for bulk density, sphericity, thousand grain weight, size, angle of repose etc were determined with variable materials at 12 % moisture content wet basis. The total 25 varieties of paddy grown in the Konkan region were studied. The mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density of eight fine variety was found as 8.09 mm, 2.07 mm, 1.70 mm, 3.04 mm, 36.15 mm^2, 0.37, 14.28 g, 28.23^0 and 543.5 kg/m^3 respectively. The ten medium varieties of paddy were studied and found the mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density as 9.11 mm, 2.46 mm, 2.02 mm, 3.56 mm, 48.25 mm^2, 0.39, 22.77 g, 29.82^0 and 562.9 kg/m^3 respectively. Also eight coarse varieties were studied and found the mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density as 8.95 mm, 2.77 mm, 2.04 mm, 3.70 mm, 50.98 mm^2, 0.41, 26.02 g, 29.94^0 and 600.5 kg/m^3 respectively.

Keywords: Physical properties, Paddy, Konkan Region

Introduction

Rice (*Oryza sativa*) is very important crop among all the food grains. Around 3/4th population of world takes the rice as the staple food as the major constituent of their daily diet. India is the second largest producer of rice after the china with 106.54 million tons production (Anonymous, 2014). In Maharashtra Konkan region is basically a narrow strip of 40 km wide and running 750 km of length from north to south, and is a hilly terrain lying between Sahyadri ranges in the east and Arabian Sea in west. Mostly wet land cultivation system is followed in Konkan region whereas in most of the parts of western Maharashtra and northern Konkan region upland rice cultivation is preferred. The need to increase production and improve quality of locally produced rice to make it more competitive with imported rice cannot be over emphasized. Several factors have been found to account for this variable quality; the one is the poor physical properties (Oludare *et al.,* 2012). The physical and mechanical properties of rice, which are in the design and selection of

storage structures and storage and processing equipments, depend on the grain moisture content (Jouki and Khazaei, 2012). Seed properties are important factors for optimizing the parameters of the design of seed drill. Therefore determination and consideration of properties such as size, sphericity, surface area, bulk density, thousand grain weight, and angle of repose has prime importance.

Knowing the grains bulk density be useful in the sizing the grain hopper (Jouki and Khazaei, 2012). Some physical characteristics of the rice such as grain thickness has a major effect on the volume expansion ratio of the cooked rice followed by degree of milling and then by apparent amylase content of the grain (Mohapatra and Bal, 2007). The thousand grain weight of paddy grain is used for calculating the head rice yield (Mehdi *et. al.* 2007). Based on the investigation performed by the Srivastava *et. al.* (1990), grain bulk density and angle of repose are related to separator performance, while harvesting grain, such that increasing grain density increases separator capacity, while increasing the grain angle of repose has the opposite effect.

The attempt was made to study the some physical properties of paddy seed in relation to seed metering mechanism. The seed for the experiment was obtained from the Department of Agronomy, DBSKKV, Dapoli. The paddy varieties selected for the study were classified as fine, medium and coarse variety. The physical properties of paddy namely; thousand grain weight, size and surface area, bulk density, angle of repose are required for the design of seed drill and processing equipments are investigated and presented.

Materials and methods
The Paddy varieties selected for the study were classified as fine, medium and coarse variety based on the physical properties of Paddy namely; thousand grain weight, size

and bulk density. The methods used for determination of physical properties are described as follows.

Size, sphericity and surface area
The size was determined by measuring the dimension of the principal axes; major, intermediate and minor axes of randomly selected Paddy i.e. length, breadth and thickness using digital vernier caliper to an accuracy of 0.01 mm. The size and surface area were calculated using the following equations (Mohsenin, 1986). The ten grains were selected randomly from sample and dimensions were measured. The mean and standard deviation of dimensions were calculated.

$$Size = \sqrt[3]{(Length \times Breadth \times Thickness)} \quad ...(1)$$

$$Surface\ area = \frac{13}{11} \times (Breadth + Thickness) \times Length \quad ...(2)$$

$$Sphericity = \frac{Size}{Length} \quad ...(3)$$

Bulk density
The bulk density was found by taking Paddy in a container of cylindrical shape. The volume of the container was found by measuring diameter and height for cylindrical container. The weight of the grain in the container was found separately. The bulk density was calculated. The three samples of each variety were taken and mean bulk density was calculated.

$$Bulk\ Density\ (kg/m^3) = \frac{Weight\ of\ sample,\ kg}{Volume\ occupied\ by\ the\ sample,\ m^3} \quad ...(4)$$

Thousand grain weight
1000 grains were selected randomly and then weighed to obtain the thousand grain weight in gram. The ten sample of each

variety was weighed and mean thousand grain weight of each variety was found out.

Angle of repose
The Paddy seeds were filled in the feed hopper of the experimental set up. Seeds were allowed to fall vertically to form a natural inverted cone. The height of the inverted cone was measured. The angle of repose is the angle between the base and the slope of cone formed on a free vertical fall of the material to a horizontal plane.
The angle of repose was calculated using the equation, (Varnmakasti *et al.,* 2007)

$$\theta = \tan^{-1}\left(\frac{2H}{D}\right) \qquad \ldots(5)$$

Where, θ is angle of repose, deg
   H is height of cone, mm
   D is diameter of cone, mm

The instrument and test setup for physical properties determination is shown in Fig. 1. The physical properties of eight fine, eleven medium and eight coarse size Paddy varieties were determined and their mean is presented. These properties are useful for design of different component of seed cum fertilizer drill and processing equipments.

Result and discussion
Seed properties are important for optimizing the parameters of the seed drill and processing equipments. Hence attempt was made to study the physical properties of paddy seeds grown in Konkan region in relation to seed metering mechanism and processing equipments. The total 25 varieties were studied and classified as small(Karjat-4, Karjat-8, Palghar-2, Ratnagiri-5, Ratnagiri-24, Palghar-1, Ratnagiri-Purple, Karjat-184), medium(Hansa Sahyadri-4, Ratnagiri-711, Karjat-2, Phondaghat-1, Panvel-2, Vashishti Sahyadri-2, Ratnagiri-7, Karjat-1, Karjat-3 and Panvel-1) and coarse(Ratnagiri-4, Ratnagiri-3, Ratnagiri-73, Karjat-5, Panvel-3, Ratnagiri-3 and Ratnagiri-1) which are

grown in the Konkan region. The seeds were cleaned to remove foreign matter, broken and immature seeds. The moisture content was determined by oven dry method and was found to be 12 per cent wet basis.

The physical properties of agricultural materials had been found useful for designing hopper and seed metering mechanism and processing equipment. The physical properties of paddy namely; thousand grain weight, size and surface area, bulk density, angle of repose were measured using standard procedure. The physical properties such as length (L), breadth (B), thickness (T), size (S), surface area (SA) and sphericity (Sp) of eight fine varieties was found as ranges from 7.27 to 9.19 mm, 1.84 to 2.37 mm, 1.58 to 1.88 mm, 2.8 to 3.43 mm, 30.17 to 45.83 mm^2, 0.36 to 0.39 respectively. The thousand grain weight (TGW), angle of repose (AR) and bulk density (B.D.) of eight fine varieties was found as ranges between 10.5 to 22.26 g, 27.35^0 to 33.18^0 and 481 to 585 kg/m^3 respectively. The mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density of eight fine varieties was found as 8.09 mm, 2.07 mm, 1.70 mm, 3.04 mm, 36.15 mm^2, 0.37, 14.28 g, 28.23^0 and 543.5 kg/m^3 respectively. The details of eight fine varieties are given in Table 1.

The physical properties such as length (L), breadth (B), thickness (T), size (S), surface area (SA) and sphericity (Sp) of ten medium varieties was found as ranges from 8.13 to 10.2 mm, 2.16 to 3.01 mm, 1.84 to 2.94 mm, 3.36 to 4.16 mm, 43.8 to 57.27 mm^2, 0.35 to 0.51 respectively. The thousand grain weight (TGW), angle of repose (AR) and bulk density (B.D.) of ten medium varieties was found as ranges between 20.12 to 24.01 g, 27.85^0 to 32.73^0 and 482 to 619 kg/m^3 respectively. The mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density of ten medium varieties was

found as 9.11 mm, 2.46 mm, 2.02 mm, 3.56 mm, 48.25 mm^2, 0.39, 22.77 g, 29.82^0 and 562.9 kg/m^3 respectively. The details of ten medium varieties are given in Table 2.

The physical properties such as length (L), breadth (B), thickness (T), size (S), surface area (SA) and sphericity (Sp) of seven coarse varieties was found as ranges from 7.97 to 10.03 mm, 2.46 to 2.98 mm, 1.94 to 2.13 mm, 3.59 to 3.84 mm, 46.71 to 55.11 mm^2, 0.37 to 0.45 respectively. The thousand grain weight (TGW), angle of repose (AR) and bulk density (B.D.) of seven coarse varieties was found as ranges between 24.5 to 30.03 g, 27.10^0 to 33.23^0 and 568 to 625 kg/m^3 respectively. The mean length, breadth, thickness, size, surface area, sphericity, thousand grain weight, angle of repose and bulk density of seven coarse variety was found as 8.95 mm, 2.77 mm, 2.04 mm, 3.70 mm, 50.98 mm^2, 0.41, 26.02 g, 29.94^0 and 600.5 kg/m^3 respectively. The details of eight coarse varieties are given in Table 3.

The angle of repose and bulk density were important for designing of seed and fertilizer hopper as well as seed and fertilizer metering mechanism. For designing the different sizes of cup on the basis of shape, surface area, sphericity and thousand grain weight and bulk density. The sphericity was 0.35 to 0.51, which indicate that the shape of grains makes it difficult to roll on surface. The angle of repose of all varieties is nearly equal to 30^0. The angle of repose determines the maximum angle of grain with the horizontal plane and it is important in the seed hopper design.

Conclusion

The geometrical parameters and physical properties of different 25 varieties of paddy which prevalent variety in Konkan region were studied. These are classified as small (Karjat-4, Karjat-8, Palghar-2, Ratnagiri-5, Ratnagiri-24, Palghar-1, Ratnagiri-Purple,

Karjat-184, Panvel-2), medium (Hansa Sahyadri-4, Ratnagiri-711, Karjat-2, Phondaghat-1, Panvel-2, Vashishti Sahyadri-2, Ratnagiri-7, Karjat-1, Karjat-3 and Panvel-1) and coarse (Ratnagiri-4, Ratnagiri-3, Ratnagiri-73, Karjat-5, Panvel-3, Ratnagiri-3 and Ratnagiri-1) which are grown in the Konkan region. This paper concludes with the information on physical properties of paddy varieties size, shape, surface area, sphericity, thousand grain weight, grain bulk density and angle of repose which may be useful for designing rice sowing machinery and processing equipments. Knowing the grains bulk density be useful in the sizing the grain hopper. The thousand grain weight of paddy grain is used for designing metering mechanism and estimate the head rice yield. The grain bulk density and angle of repose are related to separator performance, while harvesting grain, such that increasing grain density increases separator capacity, while increasing the grain angle of repose has the opposite effect.

Fig. 1: Instrument used for determination of physical properties of Paddy.

(a) Bulk density
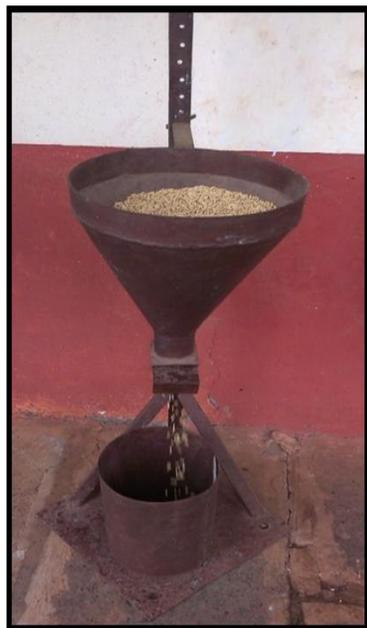
(b) Angle of repose **(c) Weighing balance** **(d) Vernier caliper**

Table 1: Physical properties of selected eight fine varieties of Paddy seeds grown in Konkan region.

Sr. No.	Variety	Parameters								
		L, Mm	B, Mm	T, mm	S, mm	S.A. mm^2	Sp	TGW, g	AR, degree	B.D. kg/m^3
1	Karjat-4	7.35	1.90	1.58	2.80	30.17	0.38	10.5	27.35	581
2	Karjat-8	7.58	1.87	1.62	2.84	31.30	0.3747	11.96	29.26	522
3	Palghar-2	9.13	2.37	1.88	3.43	45.83	0.38	12.60	28.83	585
4	Ratnagiri-5	7.75	1.84	1.59	2.83	31.43	0.37	12.60	29.21	524
5	Ratnagiri-24	8.12	2.11	1.71	3.08	36.66	0.38	15.40	29.16	547
6	Palghar-1	7.27	1.93	1.65	2.85	30.76	0.39	15.61	31.22	567
7	Ratnagiri-Purple	9.19	2.13	1.8	3.27	42.71	0.36	17.27	27.69	481
8	Karjat-184	8.36	2.26	1.83	3.25	40.37	0.39	18.31	33.18	541
Minimum value		7.27	1.84	1.58	2.8	30.17	0.36	10.5	27.35	481
Maximum value		9.19	2.37	1.88	3.43	45.83	0.39	22.26	33.18	585
Mean Value		8.09	2.07	1.70	3.04	36.15	0.37	14.28	28.23	543.5

Table 2: Physical properties of selected ten medium varieties of Paddy seeds grown in Konkan region.

Sr. No.	Variety	Parameters								
		L, mm	B, mm	T, mm	S, mm	S.A. mm^2	Sp	TGW, g	AR, degree	B.D. kg/m^3
1	Hansa Sayadri-4	10.20	2.29	1.91	3.54	50.64	0.35	20.12	32.73	497
2	Ratnagiri-711	9.81	2.16	1.85	3.40	46.47	0.35	21.60	29.57	482
3	Karjat-2	9.18	2.73	2.06	3.73	52.05	0.40	22.00	29.68	603
4	Phondaghat-1	9.39	2.27	1.88	3.43	46.23	0.36	22.29	27.85	580
5	Panvel-2	8.97	2.29	1.84	3.36	43.80	0.37	22.51	28.21	512
6	Vashishthi Sayadri-2	9.36	2.45	1.93	3.54	48.63	0.38	23.49	29.91	561
7	Ratnagiri-7	9.70	2.45	1.95	3.59	50.54	0.37	23.76	29.56	619
8	Karjat-1	8.78	2.44	1.93	3.46	45.39	0.39	24.00	28.40	580
9	Karjat-3	8.17	2.50	2.03	3.46	43.81	0.42	24.01	28.21	614
10	Panvel-1	8.13	3.01	2.94	4.16	57.27	0.51	24.01	31.43	581
Minimum value		8.13	2.16	1.84	3.36	43.8	0.35	20.12	27.85	482
Maximum value		10.2	3.01	2.94	4.16	57.27	0.51	24.01	32.73	619
Mean value		9.11	2.46	2.02	3.56	48.25	0.39	22.77	29.82	562.9

Table 3: Physical properties of selected seven coarse varieties of Paddy seeds grown in Konkan region.

Sr. no.	Variety	Parameters								
		L, Mm	B, Mm	T, mm	S, mm	S.A. mm^2	Sp	TGW, g	AR, degree	B.D. kg/m^3
1	Ratnagiri-4	9.66	2.46	1.94	3.59	50.30	0.37	24.50	30.20	589
2	Ratnagiri-2	9.08	2.79	2.09	3.76	52.45	0.41	24.90	32.79	608
3	Ratnagiri-73	7.97	2.98	1.97	3.61	46.71	0.45	25.19	27.40	575
4	Karjat-5	9.03	2.96	2.13	3.84	54.44	0.42	27.04	29.15	610
5	Panvel-3	8.30	2.76	2.04	3.61	47.22	0.43	27.01	29.04	624
6	Ratnagiri-3	8.20	2.91	2.02	3.64	47.81	0.44	28.00	27.75	630
7	Ratnagiri-1	9.37	2.75	2.10	3.79	53.81	0.40	30.03	33.23	568
Minimum value		7.97	2.46	1.94	3.59	46.71	0.37	24.5	27.4	568
Maximum value		10.03	2.98	2.13	3.84	55.11	0.45	30.03	33.23	625
Mean value		8.95	2.77	2.04	3.7	50.98	0.411	26.028	29.94	600.5

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