RESEARCH ARTICLE

EFFECT OF SOAKING TREATMENT ON ENGINEERING PROPERTIES OF DIFFERENT RICE CULTIVAR

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Abstract: Some engineering properties of rice seeds were evaluated as the function of soaking treatment i.e. dry, one day soaked and two day soaked with four different rice cultivars i.e. Rajeshwari, Swarna, Mahamaya and MTU-1010. The study showed that the engineering properties such as geometric mean diameter, thousand seed weight, bulk density and angle of repose increased as the number of soaking days increased and the values considering all the cultivar and soaking treatments were falls in the range of 3.30 to 4.11, 19.46 to 38.01 g, 571.9 to 635.08 kg m^{-3} and 21.48 to 32.40 degree respectively. The values for Sphericity and true density were found to be in the range of 0.38 to 0.45 and 1102.66 to 1264.30 kg m^{-3} respectively. Also study showed that the values of geometric mean diameter, thousand seed weight, bulk density and angle of repose varied significantly at 5 per cent level of significance for different rice cultivar.

Keywords: Rice, Engineering properties, Soaking, Rajeshwari, Mahamaya, Swarna

INTRODUCTION

The knowledge of physical and engineering properties of any biological materials are important not only for categorizing the seeds into different sub groups but they are rather more important for designing of handling and processing equipment and processes. The design of farm machines such as planters, seed drills as well as threshers wholly depends on the engineering or physical properties of the seed which to be handle. The engineering properties such as size, shape, bulk density and true density, angle of repose and thousand grain weight influences the performance of seed metering mechanism. Seed size and shape is required for designing of groove length, depth and width of cell shape for seed metering plate. The angle of repose is important to decide the slope for free flow of seed from hopper as well as inclination for the seed metering plate. The bulk density and true density values are important to decide thickness of material of construction for seed hopper as well as design of seed hopper. The thousand grain weight is required to determine the number of grain per square meter area for a desired seed rate. The objective of this study was to determine some engineering or physical properties of selected rice cultivars i.e. shape, size, thousand seed weight, bulk density, true density and angle of repose and determine their relationship with number of soaking days.

MATERIALS AND METHODS

The samples of four different rice cultivars from Chhattisgarh state i.e. Rajeshwari, Swarna, Mahamaya and MTU 1010 collected from the IGKV farm were cleaned manually to remove all foreign substances such as soil, stones, chaff, dust as well as immature and broken seeds. The hydro priming treatment was given to the selected cultivar as per the farmer's method (soaking the seeds inside the wet gunny bag) (plate 1) such as dry, one day soaked and two day soaked.

Plate 1. Soaking treatment as per farmer's method

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A sample of 100 seeds of each variety was taken.A digital Vernier calliper was used to measure along three directional axes as length, breadth and thickness. Geometric mean size of seed affects the groove length and depth of rotor in seed metering plate. It was calculated by following equation (Mohsenin, 1996)

Geometric mean = $\sqrt[3]{(l \text{ X } b \text{ X } t)}$ …1

Sphericity affects the uniform free flow of rice seed from the metering plate groove surface. It was calculated by following equation (Mohsenin, 1996)

$$\text{Sphericity} = \sqrt[3]{\frac{(l \text{ X } b \text{ X } t)}{l}} \quad \ldots 2$$

Where,l = length of rice seed (mm), b = breadth of rice seed(mm), t = thickness of rice (mm)

One thousand grains were selected randomly and then weighed to obtain the thousand grain weight in gram. The ten sample of each variety was weighed using an electronic balance and mean thousand grain weight of each variety was recorded (Ghasemi*et al*., 2007). The methods described by the Mohsenin (1996) were used to determine the bulk and true density of rice seeds at different soaking treatments. The bulk density was determined as:

$$\rho = \frac{W}{V} \quad \ldots 3$$

Where, ρ = Bulk density (g cm^{-3}), W = Weight of rice seed (g), V = Volume of sample (cm^3)

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, (Ghasemi*et al*., 2007)

$$Ø = \tan^{-1}\left(\frac{2H}{D}\right) \quad \ldots 4$$

Where, Ø = angle of repose (degree), H = height of heap (cm), D = diameter of base plate (cm).

RESULTS AND DISCUSSION

Table 1. Mean values for various properties of different rice cultivar under different soaking conditions.

Variety	Soaking treatment	Engineering properties of rice seed					
		Geometric mean diameter (mm)	Sphericity	Thousand seed weight (g)	Angle of repose (degree)	Bulk density (kg m^{-3})	True density (kg m^{-3})
V_1	dry	4.01	0.43	31.03	22.8	579.83	1213.235
	1 day soaked	4.11	0.43	35.56	27.43	571.9	1182.95
	2 day soaked	4.18	0.44	37.87	32.4	588.24	1206.972
V_2	dry	3.30	0.43	19.46	21.48	579.83	1231.061
	1 day soaked	3.33	0.45	24.07	27.32	622.83	1235.433
	2 day soaked	3.53	0.43	26.72	30.21	609.40	1102.663
V_3	dry	3.70	0.40	29.43	24.67	597.15	1194.296
	1 day soaked	3.82	0.43	36.44	26.24	635.08	1264.305
	2 day soaked	4.00	0.44	38.01	30.93	579.83	1276.582
V_4	dry	3.46	0.38	24.96	26.45	571.9	1176.471
	1 day soaked	3.63	0.38	28.43	29.56	573.07	1207.686
	2 day soaked	3.65	0.38	31.9	31.86	579.83	1249.402

V_1-Rajeshwari; V_2 – Swarna; V_3- Mahamaya; V_4- MTU 1010

Plate 2. Effect of soaking treatment on rice seed

Size and shape

The size and shape of selected rice cultivar were determined by using the mentioned methods.The observed values for mean length, breadth, thickness and geometric mean diameter of rice cultivar under dry, one day soaked and two day soaked conditions were in the range of 7.00 - 11.00, 2.00 - 3.50, 1.50 - 3.00 and 2.93 - 4.48 mm respectively. The lowest seed length of 7.63 mm was observed for Swarna cultivar under dry condition and highest of 9.67 mm for Rajeshwari cultivar under 2 days soaked condition. The increased number of soaking days increased the length, breadth and thickness of the selected rice cultivar. This trend was observed due to the fact that the increased number of soaking days increases the moisture content of the seeds resulted into the swelling, which in turn increased the diameter in all the directions. Similar results were reported by Ghadge *et al*. (2012), Patel *et al*. (2013), Vengaiah *et al*. (2015) and Putri *et al*. (2018).

Geometric mean diameter was found to be lowest in case of Swarna cultivar under dry condition (3.30 mm) while highest (4.18 mm) for Rajeshwari cultivar under two day soaking condition (Table 1). The analysis showed that the geometric mean diameter varied significantly (CD=0.114) for different cultivar but soaking treatment had no significant difference on it.

The values of sphericity were calculated as per the equation 2 by using the data on length, breadth and

thickness for each cultivar. The average mean value for sphericity of rice cultivar under different treatments of soaking was recorded as 0.42. The lowest and highest sphericity were observed with MTU 1010 and one day soaked Swarna cultivar respectively.The sphericity value for selected rice cultivar was observed to be different with each other.

Thousand seed weight

Thousand seed weight for all the selected rice cultivar was found in the range of 19.46 to 38.01 gram. The thousand seed weight for all the cultivars i.e. Rajeshwari, Mahamaya, Swarna and MTU 1010 varied significantly (CD = 0.47). It was observed to be highest for Rajeshwari cultivar (38.82 g) whereas lowest (23.41g) for Swarna cultivar. The number of soaking days significantly affected the thousand seed weight for selected cultivar. It was also observed that the increased number of days for soaking increased the thousand seed weight and this change was significant at 5 per cent level of significance (Fig.1). The similar results of effect of soaking treatment on thousand seed weight was reported by Bhatacharya*et al*. (1972), Princewell and Ezinne (2014) and Putri *et al*.(2018).

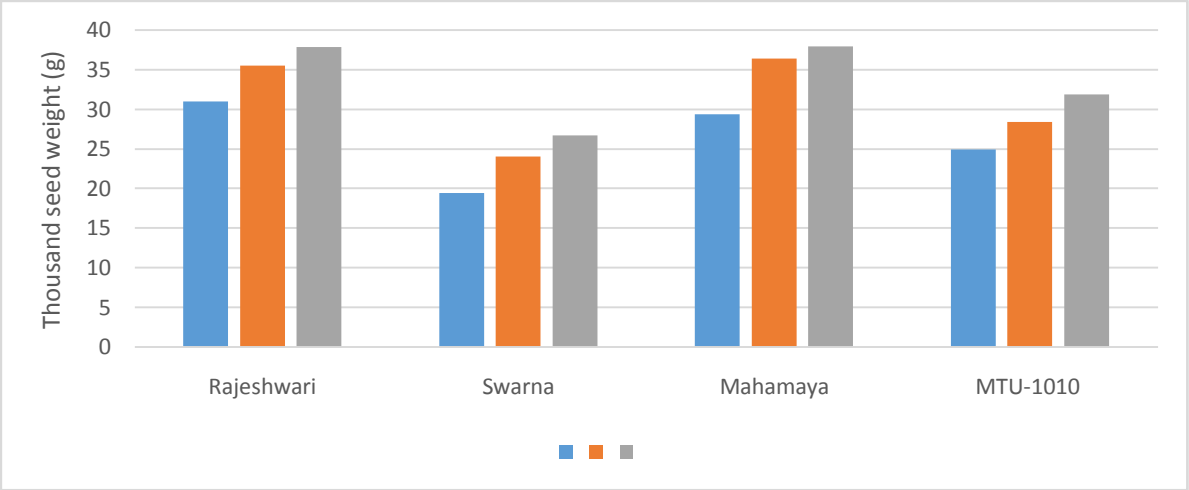

Fig. 1. Effect of soaking treatment on thousand seed weight of different rice cultivar.

Angle of repose

Angle of repose for all the selected rice cultivar was found in the range of 21.48 to 32.40 degree. The minimum angle of repose (21.48) was observed for dry condition of Swarna cultivar while the maximum angle of repose (32.40) was observed for Rajeshwari in 2 day soaked condition (Table 1). The angle of repose for all the rice cultivar under dry, 1 day soaked and 2 day soaked condition were in the range of 21.48-26.45, 27.32-29.56 and 30.21-32.40 degrees respectively.

The angle of repose for all the cultivars viz. Rajeshwari, Mahamaya, Swarna and MTU-1010 vary significantly. The angle of repose was highest in case of MTU-1010 (29.29^0) whereas lowest (26.34^0) was observed in Swarna cultivar (Table 1). It was also observed that the no of soaking days significantly affected the angle of repose values. The highest 31.35^0 angle of repose was observed in two days soaked condition and was significantly different from rest of the values. It was also observed that as the number of days of soaking increased, the angle of repose increased (Fig 2). Similar results were also reported by Bhattacharya *et al*. (1972), Zareiforoush*et al*. (2011), Princewill and Ezinne (2014), Putri *et al*. (2018).

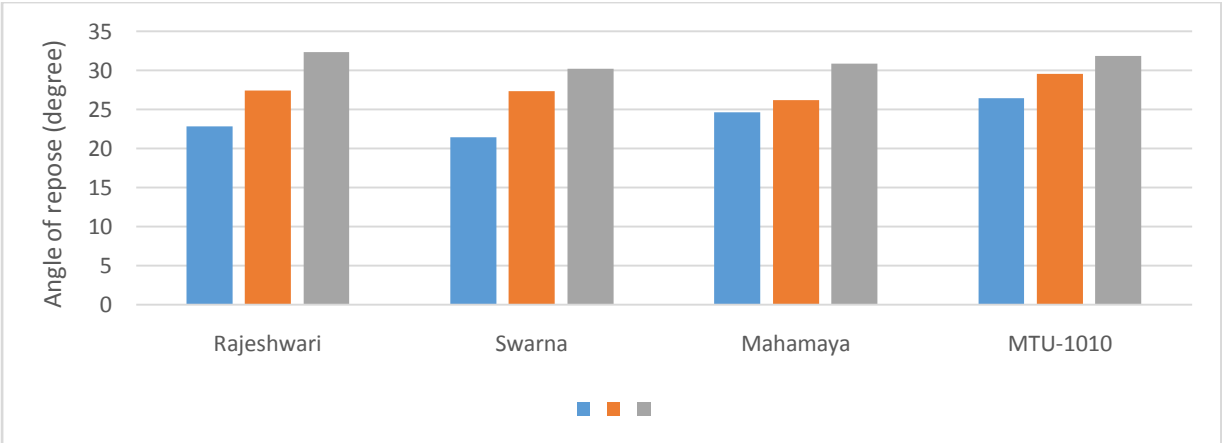

Fig 2. Effect of soaking treatment on angle of repose of different rice cultivar

Bulk density and true density

The bulk density and true density of selected rice cultivar were determined and are presented in Table 1. The bulk density values for selected cultivar were found to be in the range of 571.90 to 635.08 kg m^{-3} while the true density 1102.66 to 1276.58 kg m^{-3}. Lowest bulk density value (571.90 kg m^{-3}) was observed for Rajeshwari cultivar under one day soaked condition and highest value (635.08 kg m^{-3}) for Mahamaya cultivar under one day soaked condition. The lowest true density of 1102.66 kg m^{-3} was observed for Swarna cultivar under two days soaking condition while highest (1276.58 kg m^{-3}) was found for Mahamaya cultivar under two days soaked condition. The density values of any seeds are useful for designing the seed hopper as well as the seed metering mechanism. Bulk density decides the volume of hopper for holding and metering seed. The effect of soaking treatment on bulk density as well as true density values on different rice cultivar are shown in Fig 3.

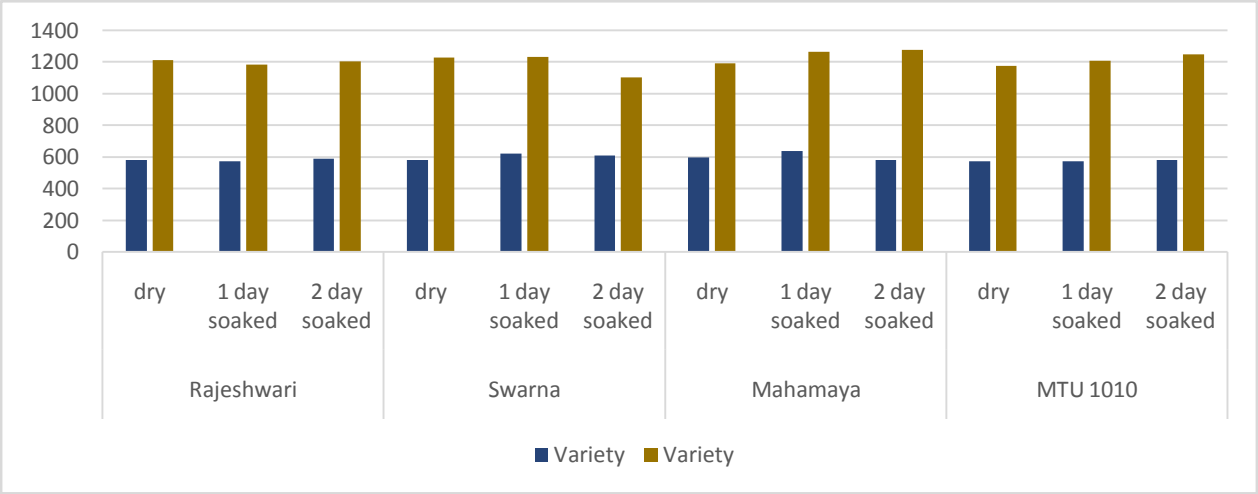

Fig 3. Effect of soaking treatment on bulk density and true density

CONCLUSIONS

The following conclusions are drawn from the study on engineering properties of rice seed for different soaking treatments.

1. Mean length, breadth, thickness and geometric mean diameter of rice cultivar under dry, one day soaked and two day soaked conditions were in the range of 7.00 - 11.00, 2.00 - 3.50, 1.50 - 3.00 and 2.93 - 4.48 mm respectively.
2. Geometric mean diameter and sphericity of selected rice cultivar under different soaking treatment varied in the range of 3.30 to 4.11 mm and 0.38 to 0.45 respectively.
3. Thousand seed weight, bulk density, true density and angle of repose of selected rice cultivar under different soaking treatment varied in the range of 19.46 to 38.01 g, 571.9 to 635.08 kg m^{-3}, 1102.66 to 1264.30 kg m^{-3} and 21.48 to 32.40 degree respectively.
4. The values of geometric mean diameter, thousand seed weight, bulk density and angle of repose varied significantly at 5 per cent level of significance for different rice cultivar.
5. Geometric mean diameter, sphericity, thousand seed weight and angle of repose increased as number of soaking days increased.

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