

## DETERMINATION OF PHYSICAL PROPERTIES OF SESAMUM

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### ABSTRACT

*India is the largest producer and consumer of sesamum in the world. Manual broadcasting of small sesamum seeds in field is a slow and labor-intensive operation. Therefore, seeding operation of sesamum should be mechanized to increase the capacity of sowing. Manually operated seed drill was developed to sow sesamum seeds. To reduce the miss- seeding and reseeding rates of seeders, the developed seed drill was tested for main varieties of sesamum viz., Gujarat Til-2 and Gujarat Til-3. The physical characteristics like geometrical size, sphericity, bulk density, angle of repose and shape of sesamum seeds were measured. The results showed that the average geometrical sizes i.e. length, width and thickness were found to be 3.07, 1.85, and 0.97 mm, respectively in Gujarat Til-2, while they were noted 3.02, 1.76, and 0.82 mm, respectively in Gujarat Til-3. Average sphericity of sesamum seeds was 0.571 and 0.538 in Gujarat Til 2 and Gujarat Till 3, respectively. The bulk density and angle of repose were noted 0.632 g/cc and 33.82°, respectively in Gijarat Til 2, whereas they were 0.693 g/cc and 32.89°, respectively in Gijarat Til 3. The shape of both the varieties was found very long.*

**KEY WORDS:** Angle of repose, Geometric size, Physical properties, Sesamum, Shape, Size

### INTRODUCTION

Sesamum (*Sesamum indicum* L.) is one of the oldest oilseeds crops domesticated well over 3000 years ago. Sesamum has many species, most being wild and native to Sub-Saharan Africa. *Sesamum indicum*, originated in India is widely cultivated. Sesamum is highly tolerant to drought and grows where other crops may fail. Sesamum seed is largely grown in the eastern and western parts of India.

The total area under cultivation for sesamum in India is about 1650 thousand hectares overall. The production of sesamum

seeds in India is 540 thousand tons, out of which Gujarat produced 180-200 thousand tons (Bhardwaj *et al.*, 2014). Gujarat is ranking first in area under sesamum crop as compared to all other states of India. Thus, sesamum is an important crop for the state of Gujarat. Sesamum seed production in Gujarat is about 43000 tons in 2012-13, which increased up to 75000 tons in 2014-15 (Chandel *et al.*, 2014).

The physical properties of sesamum seeds are required for designing and developing the sowing equipment. The size and shape of seeds determines the size and shape of drum seeder while designing the

openings in sowing equipment. Bulk density and porosity affect the structural seed carrying unit. So the objective of this study was to investigate some geometrical size, sphericity, bulk density, angle of repose, and shape of sesamum seeds.

### MATERIALS AND METHODS

The main variety of sesamum Gujarat Til-2 and Gujarat Til-3 were considered for the study. The measurements were carried out at the Department of Farm Machinery and Power Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh.

#### Size

The size of sesamum seeds was measured in terms of length (l), width (b) and thickness (t). 100 seeds were taken and dimensions l, b and t were measured at three major axes with the help of vernier caliper having least count 0.1 mm.

$$D_e = (lbt)^{1/3} \quad \text{..... (1)}$$

#### Sphericity

The sphericity of sesamum seeds ( $\phi$ ) was calculated by using the following relationship (Mohsenin, 1980).

$$\phi = \frac{(lbt)^{1/3}}{l} \quad \text{..... (2)}$$

#### Bulk density

The seeds were filled in a 200 cc capacity cylinder without under pressure and its weight was measured on an electronic balance having least count of 0.1 g. The bulk density was determined as weight of material per unit volume, g/cc. The average bulk density was determined by taking arithmetic mean of five samples.

#### Angle of repose

The angle of repose of seeds was determined by the method explained by Waziri and Mittal (1983). The seeds were allowed to fall from a height until maximum height was reached and the height of seed heap was noted. The experiment was replicated five times and the average values were computed (Figure 1).

The following equation was used to calculate the angle of repose of the selected seeds.

$$\theta = \tan^{-1} \left( \frac{h}{r} \right) \quad \text{..... (3)}$$

Where,

$\theta$  = Angle of repose (degree),

$h$  = Height of pile (mm), and

$r$  = Radius of pile (mm)

#### Shape

The shape of sesamum seeds was determined by using the following equation and observing the indicator as given in Table 1.

$$\text{Indicator} = \frac{(l)^2 \times 100}{(b \times t)} \quad \text{..... (4)}$$

### RESULTS AND DISCUSSION

The results showed that geometrical sizes i.e. length, width and thickness in Gujarat Til-2 and Gujarat Til-3 were found in the range of 2.47-3.40 mm, 1.48-2.09 mm and 0.67-1.44 mm, respectively. The average geometrical sizes i.e. length, width and thickness were found to be 3.07, 1.85, and 0.97 mm, respectively in Gujarat Til-2, while they were noted 3.02, 1.76, and 0.82 mm, respectively in Gujarat Til-3 (Table 2 and 3). Sphericity of Gujarat Til-2 and Gujarat Til-3 was found in the range of 0.483-0.642, with an average sphericity of 0.571 and 0.538 in Gujarat Til 2 and Gujarat Til 3, respectively. The bulk density of both varieties was found in the range of 0.629-0.695 g/cc with average bulk density of 0.632 g/cc in Gujarat Til 2 and 0.693 g/cc in Gujarat Til 3. The angle of repose was 33.82° for Gujarat Til-2 and 32.89° for Gujarat Til-3.

Shape of both variety was find out based on equation 4 and Table 1 as under:

For Gujarat Til-2,

$$\begin{aligned} \text{Indicator} &= \frac{(l)^2 \times 100}{(b \times t)} \\ &= (3.072)^2 \times 100 / (1.854 \times 0.975) \\ &= 522.06 \end{aligned}$$

For Gujarat Til-3,

$$\begin{aligned} \text{Indicator} &= \frac{(l)^2 \times 100}{(b \times t)} \\ &= \frac{(3.02)^2 \times 100}{(1.76 \times 0.821)} \\ &= 631.18 \end{aligned}$$

The shape indicator was found in the range of very long shape based on Table 1 for the both variety Gujarat Til-2 and Gujarat Til-3. So, the shape of both varieties was very long.

The results reported under the present study on various geometrical sizes i.e. length, width and thickness, Sphericity, bulk density and angle of repose in sesamum are similar to the results reported by Tunde-Akintunde and Akintunde (2004) in order to design equipment for improved processing of sesame seed. They noted that the average dimensions of sesame seed viz., length, width and thickness were 2.80, 1.69 and 0.82 mm, respectively. The average geometric mean diameter, sphericity, surface area and density were observed to be 1.56 mm, 0.56, 7.80 mm<sup>2</sup> and 1224 kg/m<sup>3</sup>, respectively. The average coefficient of friction varied from 0.39 on glass to 0.54 on plywood, while the angle of repose was 32.0°.

### CONCLUSION

In the present investigation, The average geometrical sizes i.e. length, width and thickness were found to be 3.07, 1.85, and 0.97 mm, respectively in Gujarat Til-2, while they were noted 3.02, 1.76, and 0.82 mm, respectively in Gujarat Til-3. These

properties are useful in the design of openings size seeder and number of openings on the drum. Average bulk density of Gujarat Til-2 and Gujarat Til-3 were found to be 0.632 g/cc and 0.693 g/cc, respectively, which is useful for determining the volume of drum of drum seeder.

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**Table 1: Shape indication of the sesamum seeds**

| Shape     | Indicator  |
|-----------|------------|
| Round     | 100 to160  |
| Oval      | 161 to 240 |
| Long      | 241 to 340 |
| Very long | Above 340  |

**Table 2: Physical properties of sesamum seeds (Gujarat Til- 2)**

| Sr. No. | Name of Physical Property | Minimum                 | Maximum | Average |
|---------|---------------------------|-------------------------|---------|---------|
| 1       | Size                      | Length, mm              | 2.81    | 3.40    |
|         |                           | Width, mm               | 1.48    | 2.09    |
|         |                           | Thickness, mm           | 0.76    | 1.44    |
|         |                           | Equivalent diameter, mm | 1.57    | 2.12    |
| 2       | Sphericity                | 0.524                   | 0.642   | 0.571   |
| 3       | Bulk density, g/cc        | 0.629                   | 0.634   | 0.632   |
| 4       | Angle of repose, degree   | 33.42                   | 34.22   | 33.82   |

**Table 3: Physical properties of sesamum seeds (Gujarat Til- 3)**

| Sr. No. | Name of Physical Property | Minimum                 | Maximum | Average |
|---------|---------------------------|-------------------------|---------|---------|
| 1       | Size                      | Length, mm              | 2.47    | 3.32    |
|         |                           | Width, mm               | 1.53    | 1.96    |
|         |                           | Thickness, mm           | 0.67    | 0.96    |
|         |                           | Equivalent diameter, mm | 1.36    | 1.76    |
| 2       | Sphericity                | 0.483                   | 0.567   | 0.538   |
| 3       | Bulk density, g/cc        | 0.691                   | 0.695   | 0.693   |
| 4       | Angle of repose, degree   | 32.61                   | 33.26   | 32.89   |



**Figure 1: Angle of repose measuring device**

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