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Study of Physico-Mechanical Properties of Sesame Crop for Design of a Thresher

Kailashkumar.B[1]

Doctoral Student in Farm Machinery & Power Engineering, Department of Farm Machinery & Power Engineering, Agricultural Engineering College & Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India[1]

Abstract: Sesame seed is one of the oldest oilseed crops known, domesticated well over 3000 years ago. Sesamum has many other species, most being wild and native to sub-Saharan Africa. Sesame can be harvested 90 to 150 days after planting. The crop must be harvested before the shattering damages it. Mechanical threshing is recommended to minimize seed damage and loss during harvesting.

Keywords: Sesame, Crop Parameters, Design, Sesame Grains.

I. INTRODUCTION

The sesame crop stalks immediately after harvest are stacked one over the other in a circular heap with the stems pointing up and the grain portion pointing down. The top portion of heap is covered with straw to increase the humidity and temperature of the heap. This curing process is continued for three days and due to initial shaking after that, about 25 per cent of the seeds will fall off the stalks and this method is tedious and time-consuming process. It is seen that manual threshing accounts for 20 per cent of the total labour requirement in sesame cultivation. For mechanical threshing the following measurements is considered for design aspects.

II. CROP PARAMETERS

Effective length and thickness of sesame crop stalk

Ten sesame stalks were selected at random from the harvested heap. One of the selected sesame stalk was placed on a horizontal platform in its natural rest position and its total length, effective length (length of stalk having sesame capsules) and thickness was measured. The mean values of total length, effective length and thickness of sesame crop stalk are furnished in the table. These values are used for computation of length of the concave and concave clearance.

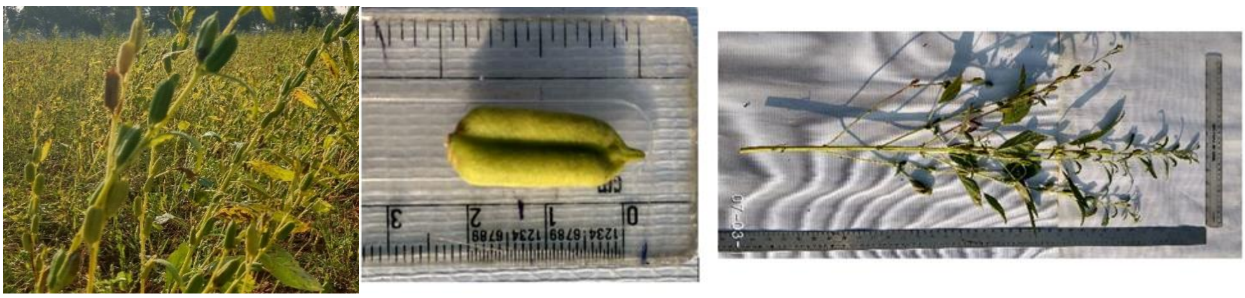

Fig. 1 Measurement of length and width – Crop parameters

Table 1. Mean value of length and thickness of sesame crop stalk

S.No.	Stalk thickness (mm)	Harvested Stalk length (mm)	Effective stalk length (mm)
i.	7.3	675	600

Length, width and height of sesame capsule

Ten sesame capsules were selected at random from the harvested heap. The dimensions *viz.*, length, width, and thickness of selected sesame capsule are measured by using digital Vernier calliper having an accuracy of 0.02 mm. These values are used for computation of concave mesh dimensions.

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Table 2. Mean value of length, width and height of sesame crop stalk

S.No.	Capsule	Length (mm)	Width(mm)	Height (mm)
i.	Sesame TMV 4	7.99	5.65	20.37

Thousand grain weight

The weight of thousand grains randomly selected from a ten heap of sesame crop was measured using an electronic weighing balance having a sensitivity of 0.1g. The recorded observations are furnished and the mean values are taken for design considerations.

Table 3. Mean value of thousand grain weight

S.No.	Grain	Thousand grain weight (g)
i.	Sesame TMV 4	3

The thousand-gram seed weight is used for the calculation of total mass of grains in a stalk for threshed and unthreshed sesame capsules.

Weight of grains per capsule

The harvested sesame crop stalks with capsules was kept as 10 bundles of 5 kg each. The number of sesame stalks per bundle was counted and recorded. Ten sesame stalks with capsules were selected at random from the harvested heap. The number of sesame capsules in each stalk was counted. The procedure was repeated for the other selected sesame stalks. Then ten number of sesame capsules were selected at random and number of sesame grains in each capsule was counted.

Table 4. Mean value of weight of grains per capsule

S.No.	Crop	No. of capsules per sesame stalk	No. of grains per capsule	No. of harvested sesame stalks per bundle
i.	Sesame TMV 4	42	45	358

The total weight of the sesame grains input of the thresher is calculated as furnished below.

No. of capsules per sesame stalk = 42
No. of grains per capsule = 45
Thousand sesame grain weight = 3 g
No. of harvested sesame stalks per bundle = 358
Weight of sesame stocks per bundle, kg = 5
Total sesame grain input of thresher, kg = (42 x45 x 358 x 3)/1000
= 2.029 = 2.0

Size and shape of grain

The size and shape of the grain are important parameters used in design of cylinder concave and sieve assembly of thresher. The sesame grains have an oval shape with three main dimensions, the length (longitudinal dimension), the breadth (dorsoventral dimension) and thickness (lateral dimension). Ten sesame grains of TMV 4 variety were selected in random and the dimensions *viz.*, length, width, and thickness of selected TMV 4 variety sesame grains were measured by using digital vernier caliper having an accuracy of 0.02 mm.

Fig. 2 Measurement of length and width – grain parameters

Table 5. Mean value of length, width and thickness of the grain

S.No.	Grain	Length (mm)	Width (mm)	Thickness (mm)
i.	Sesame TMV 4	3	1.7	0.8

These values are used for the selection of size of the holes for top and bottom sieves in the thresher.

Bulk density

The bulk density influences the design of volume of thresher and is affected by the moisture content and degree of packing. The bulk density of selected variety of sesame grains was computed by measuring the volume of known weight of sesame grain samples. A grain sample of known weight was taken and filled in a graduated cylindrical jar. The volume occupied by the seeds was recorded. The procedure was repeated three times and the average value of the weight per unit volume was computed. The mean values of bulk density of selected sesame seeds furnished in the table and are used for computation of feed rate of thresher.

Table 6. Mean value of bulk density of selected sesame grains

S.No.	Crop	Variety	Bulk density, kg m^{-3}
i.	Sesame	TMV 4	0.651

III. MECHANICAL PROPERTIES OF SESAME GRAIN

The friction angle (θ), coefficient of friction, angle of repose (0^o) for sesame grain was measured to select the material for grain collection tray.

i. Friction angle (Ψ)

The frictional angle between sesame seeds and surface (metal and wood) was measured. 10 sample of sesame grains was used. These values are used for selection of material for sieve trays.

Table 7. Mean value of frictional angle of selected sesame seeds

S.No.	Types of surface	Friction angle(θ)
i.	For metal surface	34
ii.	For wood surface	40

Table 8. Mean value of coefficient of friction of selected sesame seeds

S.No.	Types of surface	Coefficient of friction of selected sesame seeds
i.	For metal surface	0.675
ii.	For wood surface	0.839

ii. Angle of repose

As the seeds flow due to gravity, the angle of repose influences the design of inclination of seed hopper. The angle of repose was measured using a rectangular box filled with sesame grains. The filled box was kept horizontal. The grains were then allowed to fall freely by gravity on a horizontal circular disc kept below the box. The grains formed a heap on the disc. The radius of the base of the heap and height of the heap were measured and angle of repose was calculated using the following expression.

$$\omega = \tan^{-1}(h/r)$$

Where,

ω = Angle of repose, θ
h = Height of heap, m
r = Radius of heap, m

This procedure was replicated ten times for accuracy and the mean value was recorded for the selected variety of sesame grains separately. The mean values are used for the design of grains collection tray.

Table 9. Mean value of angle of repose of selected sesame grains

S.No.	Crop	Variety	Angle of repose, ^{0}
i.	Sesame	TMV 4	30°

The friction angle of stainless and the coefficient of friction for stainless, 22 and 0.404. The angle of repose for was 30° was used for design of grain collection tray.

IV. CONCLUSION

The major constraints in sesame cultivation is non-availability of labour in time, especially during peak periods of harvesting and threshing. Delayed harvesting and threshing results in yield loss. Manual threshing results in higher cost of cultivation. The traditional methods of threshing operations are most time consuming, energy intensive, labour intensive, drudgery prone and uneconomical. The development of mechanical threshers for the purpose has clearly an edge over conventional methods and has reduced the drudgery of work to a great extent. The crop properties, relevant to the design of thresher components are identified and calculated.

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