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Comparative Evaluation of Bio Physical Properties of Different Varieties of Maize (Zea mays L.) Seeds In Relation To a Constant Moisture Content

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ABSTRACT:
Bio physical properties of different four varieties of maize (Zea mays L.) namely, length, width, thickness, geometrical mean diameter (GMD), sphericity, unit mass, bulk density and angle of repose as a function of moisture content (13.31% wb). Comparatively highest length, width, geometrical mean diameter, unit mass and bulk density was obtained for the variety of 4212 among the MM 7505, PARAM and KAVERI SUPER 2020 varieties of maize. Thickness and angle of repose in the wooden and alluminum surfaces was observed highest for the variety of MM 7505. KAVERI SUPER 2020 resulted highest angle of repose in G.I. sheet among the four different varities of maize.

KEYWORDS- Maize, physical properties, moisture content, angle of repose.

INTRODUCTION:

Maize (Zea mays L.) is one of the important crop among cereals and it occupies third position in production next to wheat and rice in the world. Maize is known as 'King of cereals' because of its high production potential and wider adaptability in India. It is a multipurpose crop, provides food for human, feed for animals and poultry and fodder for livestock. It is a rich source of raw material for the industry where it is being extensively used for the preparation of corn starch, dextrose, corn syrup, corn flakes etc. It has acquired dominant role in the farming sector and macro-economy of the Asian region (Mauria et al., 1998). The knowledge of physical properties constitutes important and essential engineering data in the design of machines, storage structure and processes. The value of this basic information is not only important to engineers but also to food scientist, processors and other scientists who may want to exploit these properties and find new uses (Isik and Unal, 2007). Determination of physical properties as a function of moisture content are important to design equipment for handling, conveying, separation, drying, aeration, storing and processing (Sobukola and Onwuka, 2011). The size and shape are, for instance, important in their separation from undesirable materials and in the development of sizing and grading machinery (Mohsenin, 1970). The shape of the material is important for an analytical prediction of its drying behavior (Isik and Unal, 2007).

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Bulk density, true density and porosity are major consideration in designing the drying and aeration and storage systems, as these properties affect resistance to air flow of the mass (Amin et al., 2004).

MATERIAL AND METHOD:

SEED SPECIFICATION:

Test crop : Maize (Zea mays L.)
Varieties : MM 7505, PARAM, KAVERI SUPER 2020 and 4212

AVERAGE LENGTH (L), WIDTH (W) AND THICKNESS (T):

Average length (L), width (W) and thickness (T) of 1000 seeds of each four varities of maize (i.e. MM 7505, PARAM, KAVERI SUPER 2020 and 4212) was calculated as followed:

$$L = \frac{\sum_{i=1}^{n} L}{n}$$

$$W = \frac{\sum_{i=1}^{n} W}{n}$$

$$T = \frac{\sum_{i=1}^{n} T}{n}$$

Where,
L = largest intercept (length), mm;
W= width, mm; and
T = Thickness, mm.

GEOMETRIC MEAN DIAMETER (D_P):

The geometric mean diameter (D_p) of 1000 seeds of each four varities of maize seeds was calculated by using the following relationship (Mohsenin, 1986):

$$D_p = (LWT)^{1/3}$$

Where,
L = largest intercept (length), mm;
W= width, mm;
T = Thickness, mm.

SPHERICITY (ϕ):

The sphericity of 1000 seeds of each four varities of maize seeds was calculated by the ratio of the diameter of a sphere of the same volume as that of the particle and the diameter of the smallest circumscribing sphere or generally the largest diameter of the particle (Sahay and Singh, 1994). This parameter shows the shape character of seeds relative to the sphere having the same volume.

$$\text{Sphericity} = \sqrt{\frac{\text{Volume of the particle}}{\text{volume of circumscribed sphere}}} = \frac{(LWT)^{1/3}}{L}$$

Where,
L = largest intercept (length), mm;
W= width, mm;
T = Thickness, mm.

UNIT MASS OF MAIZE SEED:

To obtain the unit mass, 1000 seeds of each four varities of maize randomly selected and weighed by using electronic balance with a least count up to 0.001g.

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BULK DENSITY OF MAIZE SEEDS:

Bulk density of maize seeds was calculated by placing the sample of seeds in a round cylinder which has 7.5 cm of diameter and 10 cm of length. The seeds were dropped from hopper into the container from a height of 20 cm and excess seeds were removed by passing a wooden stick across the top surface using 5 zigzag motions (Madamaba et al., 1993). The sample placed in the cylinder is then weighed by using electronic balance with least count of 1g. Bulk density was calculated by using the relationship.

$$b_d = \frac{Wt}{L \times \left(\pi d^2/4\right)}$$

Where,

b_d = Bulk density, kg/m^3;

W_t = Weight of sample, kg;

L = Length of cylinder, m; and

d = Diameter of cylinder, m.

ANGLE OF REPOSE:

The angle of repose is the angle between the base and the slope of the cone formed vertical fall of the granular material on a horizontal plane. The size shape, moisture content and orientation of kernel affects the angle of repose. A wooden frame with varying top surface as aluminum, Iron sheet and wood, full of maize seed sample was mounted on tilting top drafting table. The table top was tilted till the maize seed starts moving over the inclined surface. The angle of inclination was measured which shows the angle of repose of the maize seeds. Five samples were taken for determination of angle of repose.

$$\phi = \tan^{-1}\left[\frac{2(H_a - H_b)}{D_b}\right]$$

In which, ϕ, H, H and D are angle of repose, the height of cone, height of platform and diameter of the platform.

RESULT AND DISCUSSION:

LENGTH OF MAIZE SEEDS:

The length of 1000 seeds of each four varities of maize (i.e. MM 7505, PARAM, KAVERI SUPER 2020 and 4212) randomly selected and measured with the help of vernier calliper in mm at moisture content 13.31 % (wb). The average length 1000 seeds of MM 7505, PARAM, KAVERI SUPER 2020 and 4212 were observed 9.28, 9.16, 9.39 and 10.73 mm. Standard deviation in length of different four varities of maize seed was found to be 0.69, 0.89, 0.91 and 0.99. Coefficient of variation was found to be 7.50, 9.80, 9.60 and 9.20 (Table 3.1 and Fig.3.1).

WIDTH OF MAIZE SEEDS:

The width of 1000 randomly selected four varities of maize (i.e.MM 7505, PARAM, Kaveri super 2020 and 4212) seeds in mm was measured with help of vernier calliper in mm at moisture content 13.31 % (wb). The average width of 1000 seeds of MM 7505, PARAM, Kaveri super 2020 and 4212 were observed 7.57, 8.41, 6.52 and 8.70 mm. Standard deviation in width of different four varities of maize seed was found to be 0.67, 0.75, 0.32 and 0.87. Coefficient of variation was found to be 8.80, 8.90, 4.80 and 9.90 (Table 1 and Fig.2).

THICKNESS OF MAIZE SEEDS:

The thickness of 1000 randomly selected different four varities of maize (i.e. MM 7505, PARAM, Kaveri super 2020 and 4212) seeds in mm was measured with the help of vernier calliper at moisture content 13.31 % (wb). The average thickness of MM 7505, PARAM, Kaveri super 2020 and 4212 was observed 5.09, 4.71, 4.24 and 4.67 mm. Standard deviation in thickness of different four varities of maize seed was found to be

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0.70, 0.93, 0.67 and 0.77. Coefficient of variation was found to be 13.9, 19.7, 15.7 and 16.5 (Table 1 and Fig.3).

GEOMETRICAL MEAN DIAMETER (GMD) OF MAIZE SEEDS:

The GMD of 1000 randomly selected different four varities of maize (i.e. MM 7505, PARAM, Kaveri super 2020 and 4212) seeds in mm at moisture content 13.31 % (wb) was observed 7.07, 7.09, 6.35 and 7.55. Standard deviation in GMD of different four varities of maize seed was found to be 0.43, 0.52, 0.40 and 0.56. Coefficient of variation was found to be 6.10, 7.30, 6.30 and 7.40 (Table 1 and Fig.4).

SPHERICITY OF MAIZE SEEDS:

The average sphericity of 1000 randomly selected different four varities of maize (i.e. MM 7505, PARAM, Kaveri super 2020 and 4212) seeds in mm at moisture content 13.31 % (wb) was observed 0.76, 0.78, 0.68 and 0.71. Standard deviation in sphericity of different four varities of maize seed was found to be 0.06, 0.07, 0.05 and 0.05. Coefficient of variation was found to be 8.00, 9.00, 8.00 and 7.60 (Table 1 and Fig.5).

AVERAGE UNIT MASS OF MAIZE SEEDS (M)

The unit mass of 1000 randomly selected different four varities of maize (i.e. MM 7505, PARAM, Kaveri super 2020 and 4212) seeds were measured with the help of electronic weighing machine. The average unit mass of MM 7505, PARAM, Kaveri super 2020 and 4212 were found to be 0.30 g, 0.23 g, 0.26 g and 0.33 g with a CV% of 19.51, 21.90, 26.73 and 24.28 whereas SD having 0.06, 0.05, 0.07 and 0.08. This indicates that maize seeds used were relatively medium in size and fairly uniform in weight. Table 1 and Fig.6 shows the average mass, SD and CV% of different four varities of maize.

BULK DENSITY OF MAIZE SEEDS:

Three replicated trials of each four varities were conducted using a cylinder having volume 376.99×10^{-6} m^3. Average weight of MM 7505, PARAM, Kaveri super 2020 and 4212 were recorded 0.315, 0.315, 0.316 and 318 kg. Average bulk density of MM 7505, PARAM, Kaveri super 2020 and 4212 obtained 836.46 kg/m^3, 835.57 kg/m^3, 838.22 kg/m^3 and 844.41 kg/m^3 (Table:1 and Fig.7). The average bulk density of different four varities of maize was observed 838.66 kg/m^3. The bulk density of maize seeds was an important parameter for designing of box capacity.

ANGLE OF REPOSE:

The average angle of repose of MM 7505, PARAM, KAVERI SUPER 2020 and 4212 was observed 39.78°, 37.70° 38.22° and 34.42 at alluminium surface and at wooden surface 47.84°, 45.70°, 47.06°, and 38.04 (Table1 and Fig.8). Highest angle of repose was seen in wood whereas lowest angle of repose was given by G.I. sheet. The angle of repose of alluminum and GI sheet does not differ but due to higher of cost of alluminum, GI sheet was considered for lowering coefficient of friction.

Table1: Physiological properties of four varities of maize

Physiological properties		Varieties of maize (Zea mays L.)			
		MM 7505	PARAM	Kaveri super 2020	4242
Length (mm)	Mean($\bar{X}$)	9.28	9.16	9.39	10.73
	SD(σ)	0.69	0.89	0.91	0.99
	CV%	7.50	9.80	9.60	9.20
Width, mm	Mean($\bar{X}$)	7.57	8.41	6.52	8.70
	SD(σ)	0.67	0.75	0.32	0.87
	CV%	8.80	8.90	4.80	9.90
Thickness, mm	Mean($\bar{X}$)	5.09	4.71	4.24	4.67

	SD(σ)	0.70	0.93	0.67	0.77
	CV%	13.9	19.70	15.7	16.5
GMD, mm	**Mean($\bar{X}$)**	7.07	7.09	6.35	7.55
	SD(σ)	0.43	0.52	0.40	0.56
	CV%	6.10	7.30	6.30	7.40
Sphericity, ϕ	**Mean($\bar{X}$)**	0.76	0.78	0.68	0.76
	SD(σ)	0.06	0.07	0.05	0.06
	CV%	8.00	9.00	8.00	8.00
Unit mass, gm	**Mean($\bar{X}$)**	0.30	0.23	0.26	0.33
	SD(σ)	0.06	0.05	0.07	0.08
	CV%	19.5	21.9	26.7	24.3
Bulk density, kg/m^3	**Mean($\bar{X}$)**	836.46	835.57	838.22	844.41

Table 2: Mean angle of repose in different surfaces

Maize Varities	**Mean angle of repose in different surfaces**		
	Alluminium	**G.I. sheet**	**Wooden**
MM 7505	39.78°	36.06°	47.84°
PARAM	37.70°	35.72°	45.70°
KAVERI SUPER 2020	38.22°	36.30°	47.06°
4212	34.42°	32.84°	38.04°

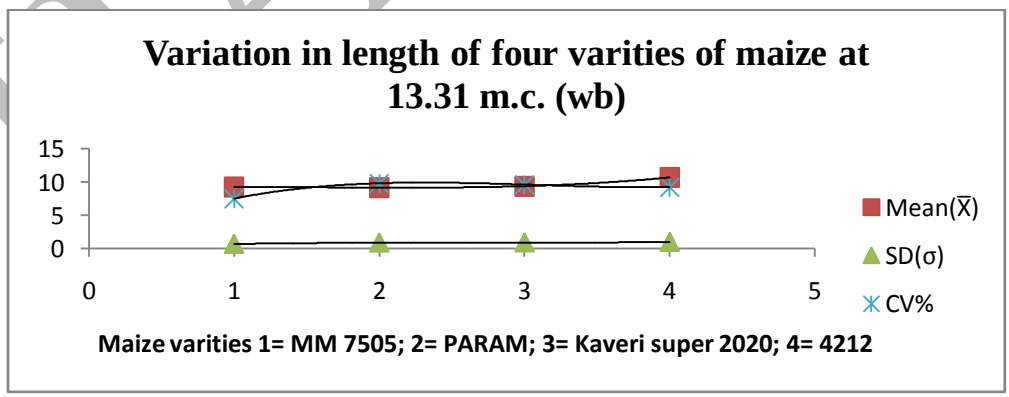

Fig.1 Variation in length, mm of four varieties of maize

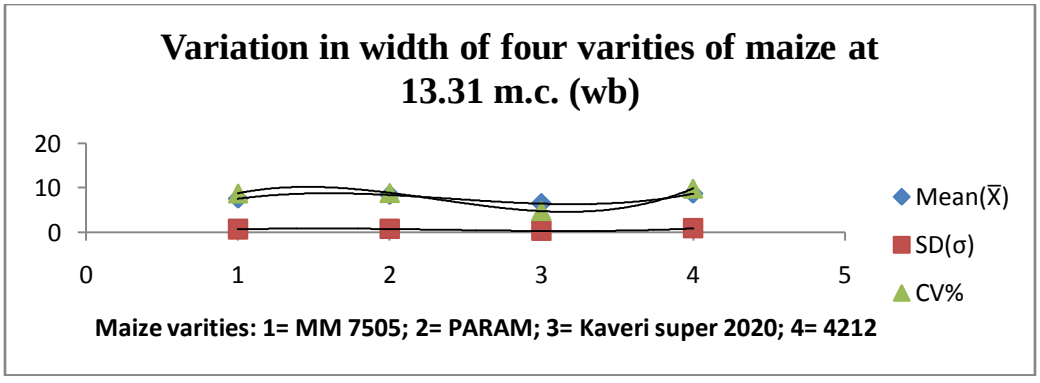

Fig.2 Variation in width, mm of four varieties of maize

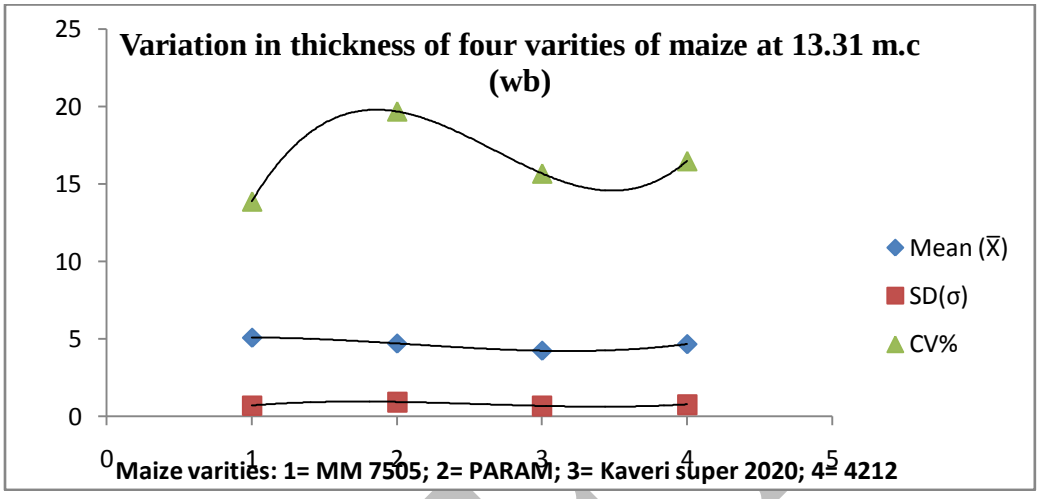

Fig.3 Variation in thickness, mm of four varieties of maize

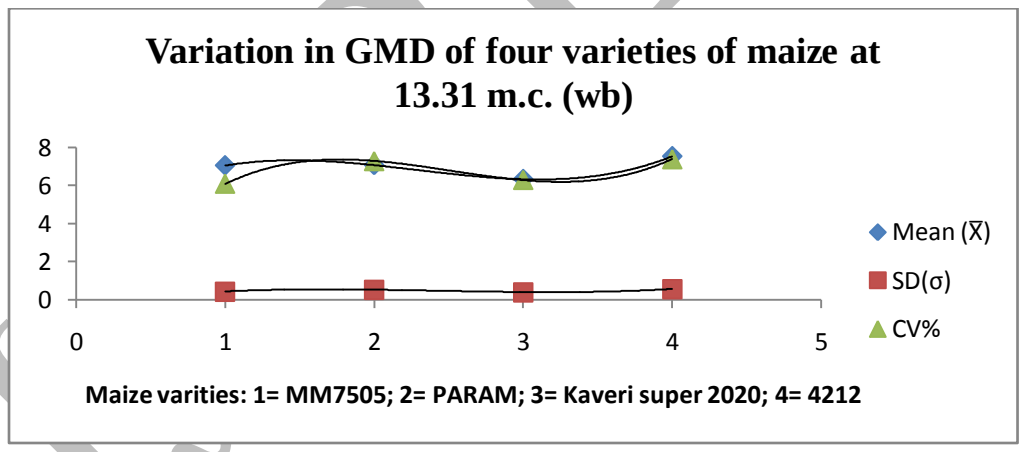

Fig.4 Variation in GMD, mm of four varieties of maize

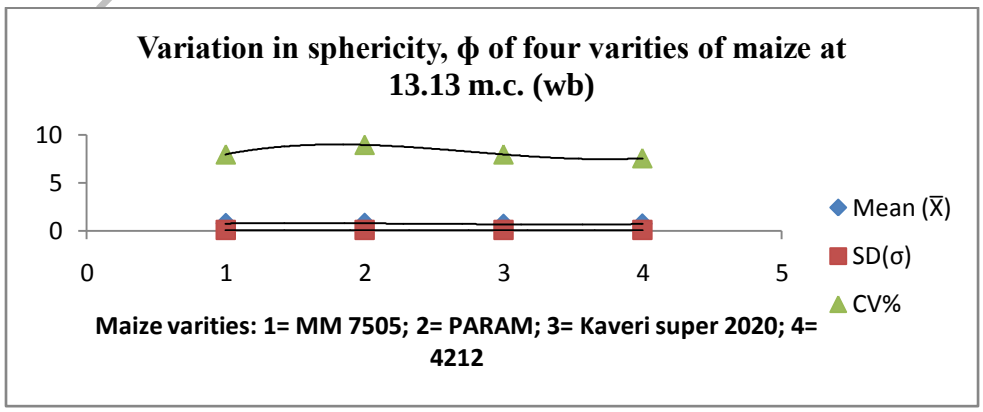

Fig.5 Variation in sphericity of four varieties of maize

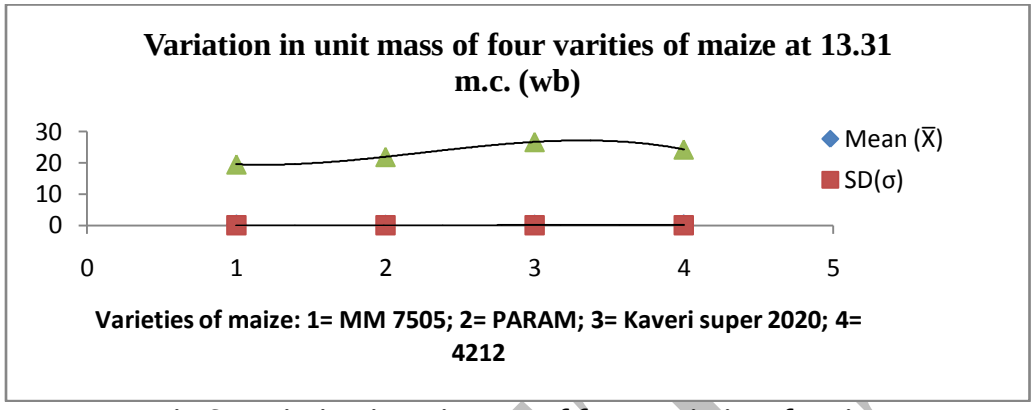

Fig.6 Variation in unit mass of four varieties of maize

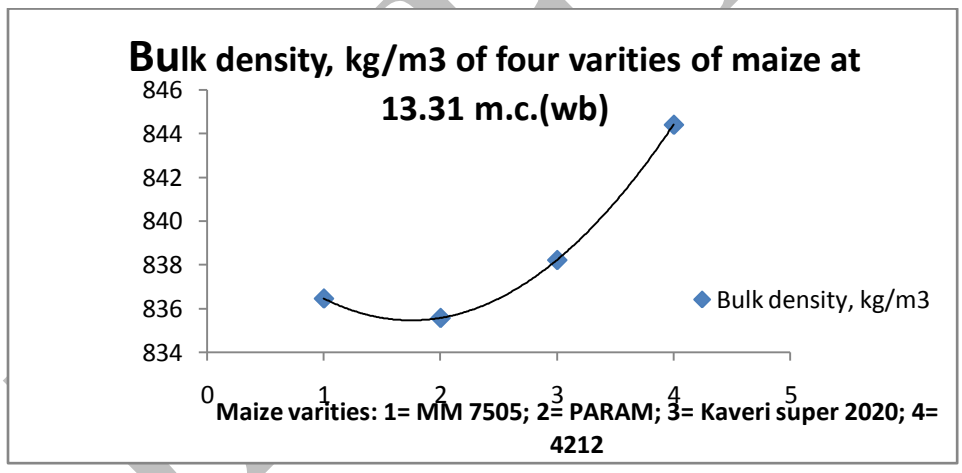

Fig.7 Variation in bulk density of four varieties of maize

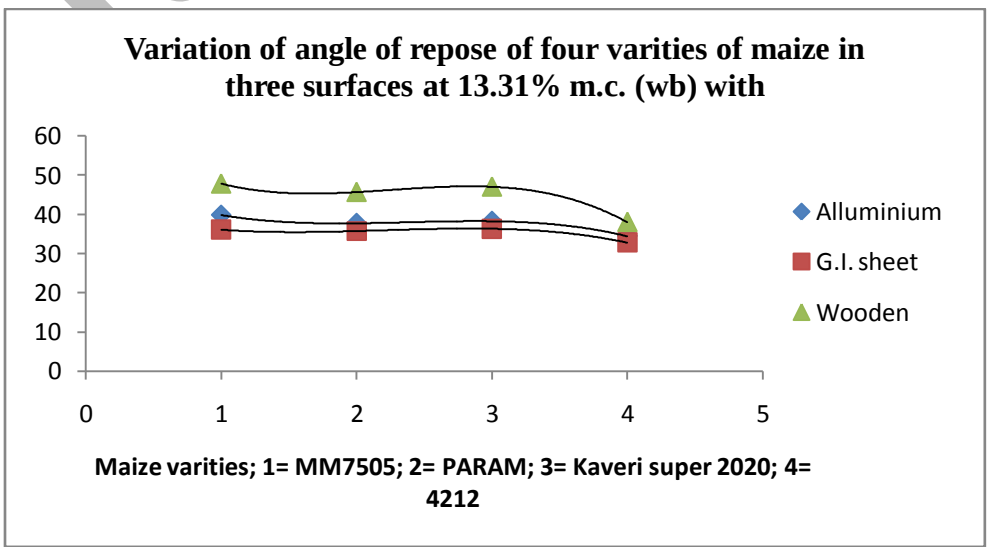

Fig.8 Variation in angle of repose of four varieties of maize at different surface

CONCLUSION:

The highest length, width, geometrical mean diameter, unit mass and bulk density of maize were concluded to 10.73 mm, 8.70 mm, 7.55 mm, 0.33 g and 844.41 kg/m^3 of variety 4212 among the four varieties. Thickness was observed highest 5.09 mm for the variety of MM 7505 in between PARAM, Kaveri super 2020 and 4212 varieties of maize. Variety MM 7505 shows highest angle of repose in wooden andalluminum surfaces which was 47.84° and 39.78° whereas Kaveri super.

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