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Research Article

Some Physico-Mechanical Characteristics of Potato Tubers Used as Seed for Development of Potato Planter

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ABSTRACT

Agriculture mechanization plays very important role for horticulture crops. Role of machineries is increasing day by day. In order to compensate for labour scarcity, reduce labour drudgery and time consumption in manual or traditional sowing of potato tubers, a prototype was designed on the basis of various mechanical properties of potato tubers and the prototype was evaluated in the field. The potato tubers taken were divided into three categories i.e., round, oblong and long-oblong. Different mechanical properties of potato tubers were used for designing different lead units of the potato tubers planter which is used for direct planting of potatoes in prepared seed bed.

Keyword: *Mechanization, Oblong, Long-oblong, Round, Angle of repose, Coefficient of static friction.*

INTRODUCTION

Potato (*Solanum tuberosum* L. Family- Solanaceae) popularly known as 'The king of vegetables' is the most important food crop in the world and has emerged as fourth most important food crop in India after rice, wheat and maize. Indian vegetable basket is incomplete without potato. It is a starchy tuberous food crop containing many vitamins and minerals. Potato is temperate crop grown under subtropical conditions in India. The fleshy part of the root (potato) is commonly eaten as a vegetable. It is rich wellspring of starch and nutrients. Planting of potato is considered as quite possibly the main activity that includes factors like right seed rate, fitting profundity of seed arrangement and required seed dispersing. For planting of potato crop land is furrowed immediately and develop double cross with roto cultivator at a profundity of 24-25 cm. Potatoes are grown in almost every state in India.

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India's major potato-growing states include Uttar Pradesh, West Bengal, Punjab, Karnataka, Assam, Bihar, Madhya Pradesh, Jharkhand, and Chhattisgarh. Potatoes are grown on 1.97 million hectares in India, with a production of 41.55 million tonnes (Mehta et al*.*, 2016). Potato is in high demand by people from all walks of life. It is famous in far off towns just as in metropolitan regions in everyday life. Various grades of engineering and mechanical characteristics of potato tubers are widely used for development and design of potato planter units.

MATERIALS AND METHODS

Different types of potato tubers viz, round, oblong and long-oblong potato tubers were used for measurement of different mechanical properties as.

Rolling-angle measurement

Rolling angle is the angle on which vegetable or fruit shapes starts rolling on the plane when it tends to increasing the slope angle of plane the angle made by the horizontal called rolling angle. The potato tubers were placed on a horizontal surface one by one then the angle of inclination was gradually increased until the tubers began to roll. For each tuber shape of an average sample of 10 tubers, the angle was determined for the maximum stable for tubers on the hopper.

Friction-angle measurement

Friction angle is that angle on which the tubers may be slide without rolling. It is the angle made from the horizontal. The potato tubers were placed as a group bounded together on a horizontal surface then the angle of inclination is gradually increased until the fruits began sliding without rolling. For each fruits group of an (10) average sample, the friction angles were determined.

Coefficient of static friction and angle of repose measurement

From friction angle, the coefficient of friction of the sample was estimated according the following equation (Mohsenin, 1986).

$$\mu = \tan \theta$$

Where:

μ = Coefficient of friction,

θ = Friction angle or angle of repose, deg.

Determination of angle of repose

The potato tubers were filled in the feed hopper of the experimental set up which is used for the angle of repose measurements. The tubers 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, (Varnmkhasti et al*.*, 2007).

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

Where,

Θ = angle of repose, degree

H = height of heap, cm

D = diameter of base plate, cm

RESULT AND DISCUSSION

Size and shape

Tubers larger than 45mm major diameter called medium oval or oblong shape tubers

Tubers larger than 55 mm major diameter called large oval or long-oblong shapes and

Tubers of 35-45mm all diameter called medium or round potato tubers. (Fig. 1 and Fig. 2).

Weight varies for all categories are; round (20-35g), oblong (35-55g) and long-oblong (55-65g) tubers. All the mean values of mechanical properties of all these three categorized potato tubers are depicted in Table 1 and Table 2 respectively.

Fig.1 Measurement of maximum, intermediate and minimum diameter of round shapes

Fig. 2: Measurement of Length, width and thickness of oblong and long-oblong shapes

Rolling and friction angles

The rolling angle was found maximum for long-oblong type of seed because of their non-homogeneity dimensions. The average values of rolling angle were 20 ± 1.58^o, 25.4 ± 1.67^o and 32 ± 1.58^o with a coefficient of variation of 7.90, 6.58 and 4.94 per cent for round, oblong and long-oblong shapes respectively and presented in Table 1.

The long-oblong shape tubers recommend higher friction angle for the sliding action. The average values of friction angle were 13.2 ± 1.30^o, 19.6 ± 1.14^o and 34.6 ± 1.14^o with a coefficient of variation of 9.87, 5.81 and 3.29 per cent for round, oblong and long oblong shapes respectively as presented in Table1.

Coefficient of static friction and angle of repose measurement

The friction of potato tubers and some vegetables against machine parts is one of the main causes of mechanical injuries during planting operation inside the hopper of vegetable planters. The knowledge of coefficient of friction is also important in the design of hoppers of potato planters, handling equipment and storage structures.

Mean static coefficient of friction of the fresh potato tubers for all sizes were measured and that was maximum for GI sheet with long oblong (oval) shape 0.581 ± 0.02 followed by oblong seed with GI sheet 0.520 ± 0.03 and round seed with GI sheet 0.400 ± 0.02 with a CV of 4.72, 5.87 and 5.88 per cent respectively. For the glass sheet the coefficient of static friction was long oblong (0.498±0.02), oblong (0.424±0.01) and round (0.354±0.02) with a CV of 4.58, 4.33 and 5.81 per cent respectively. The variation in static coefficient of friction with the test surfaces was significant at ≤ 0.05. All the mean tangent values under different materials and their coefficient of static friction for all of the shapes are depicted in Table. 2.

The mean angle of repose was found maximum for long-oblong tubers and minimum for round potato tubers. The mean angle of repose was 27.6 ± 1.14^o, 33.2 ± 1.30^o and 42.0 ± 1.51^o for round, oblong and long-oblong potato tubers correspondingly. The variance analysis of the data indicated that the difference in the coefficient of sliding friction for potato tubers was significant at a 1% probability level. The coefficient of friction on glass and galvanized iron surfaces for oblong potato tubers was greater than the corresponding values for round potatoes. According to the experimental data in Table. 2, when potato tubers are put on an inclined surface, they will roll down rather than slide down.

Table 1: Mean values of mechanical properties of all potato tubers type

Mechanical property	Samples	Mean (x̄)	CV%	SE(m)
Angle of repose	Round	27.6 ± 1.14	4.13	0.50
	Oblong	33.2 ± 1.30	3.92	0.58
	Long oblong	42.0 ± 1.51	3.56	0.67
Rolling angle	Round	20.0 ± 1.58	7.90	0.70
	Oblong	25.4 ± 1.67	6.58	0.74
	Long oblong	32.0 ± 1.58	4.94	0.70
Friction angle	Round	13.2 ± 1.30	9.87	0.58
	Oblong	19.6 ± 1.14	5.81	0.50
	Long oblong	34.6 ± 1.14	3.29	0.50

Table 2: Angles and their tangent values of coefficient of static friction for all of the shapes

Shapes	Materials	Angles for the Coeff. of static friction material based			Tangent values for the Coeff. of static friction material based		
		Mean (x̄)	CV%	SE(m)	Mean (x̄)	CV%	SE(m)
Round	Galvanized Iron sheet	21.83 ± 1.16	5.35	0.48	0.400 ± 0.023	5.888	0.010
	Glass sheet	19.50 ± 1.04	5.38	0.43	0.354 ± 0.020	5.817	0.008
Oblong	Galvanized Iron sheet	27.50 ± 1.37	5.01	0.56	0.520 ± 0.030	5.873	0.012
	Glass sheet	23.00 ± 0.89	3.89	0.37	0.424 ± 0.018	4.340	0.008
Long-oblong	Galvanized Iron sheet	30.16 ± 1.16	3.88	0.48	0.581 ± 0.027	4.721	0.011
	Glass sheet	26.50 ± 1.04	3.96	0.43	0.498 ± 0.022	4.584	0.009

CONCLUSION

Practical aspects of the kinematics and dynamics of the potato characteristics are presented in the paper. Determination of physico-mechanical properties of potatoes before designing a planter is crucial. In this investigation all the required properties were determined first and used in designing the machine which can perform tilling, planting fertilizing and ditching jobs. The design and fabrication are matched conferring to the physical and mechanical properties of the seed potato tubers according to requirement.

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