

EFFECT OF *RHIZOBIUM* COATING ON PHYSICAL AND ENGINEERING PROPERTIES OF CHICKPEA SEED

Abstract:

The physical and engineering properties of seeds are important parameters for design of metering mechanism. Physical properties namely, length, breadth, thickness, geometric mean diameter, sphericity, seed weight, bulk density, angle of repose and coefficient of static friction of uncoated, bio-fertilizer coated chickpea seeds were determined for design of metering mechanism. Free flow of seeds in the seed hopper is highly influenced by angle of repose and coefficient of static friction. Length, breadth and thickness of the uncoated and bio-fertilizer coated chickpea seeds were 9.01 ± 0.62 mm, 7.059 ± 0.69 mm, 6.57 ± 0.54 mm and 9.06 ± 0.44 mm, 7.144 ± 0.90 mm, 6.9 ± 0.22 mm, respectively. Roundness and sphericity of uncoated and bio-fertilizers coated chickpea seeds were $87.23 \pm 2.13\%$, $87.36 \pm 2.72\%$ and $81.6 \pm 3.07\%$, $82 \pm 4.15\%$, respectively. 1000 seed weight for uncoated and bio-fertilizer coated seeds were 236.65 ± 2.32 g and 237.25 ± 3.22 g respectively. Bulk density of uncoated and bio fertilizer coated seeds were 0.629 ± 0.02 g/cc and 0.641 ± 0.03 g/cc, respectively. Geometric mean diameters of uncoated and coated seeds were 7.32 ± 0.45 mm and $7.33 \pm .45$ mm, respectively. The angle of repose for mild steel surface was observed as 26.9 ± 5.61 and 29.51 ± 4.23 degree for uncoated and bio-fertilizer coated chickpea seeds, respectively.

Key words: Angle of repose, Bulk density, Geometric mean diameter, Sphericity, Static coefficient of friction.

1. Introduction

Pulses are very important protein resources in human diet, among the pulses Chickpea (*Cicer arietinum* L.) is an important pulse crop of Indian subcontinent. Chickpea is the major protein dietary for vegetarians. It also provides high quality crop residues for animal feed and helps to maintain soil fertility through biological nitrogen fixation (Herridge *et al.*, 1995; Kantar *et al.*, 2007). It is a good source of folate, rich in protein and high in dietary fibre, thus an excellent source of healthy food. India contributes 75% of the total world production of

chickpea followed by Turkey and Pakistan. India grows chickpea on about 6.67 million ha area producing 5.3 million tonnes which represents 30% and 38% of the national pulse acreage and production, respectively. India is major producer of chickpea but productivity is very low as compared to other chickpea producing countries. India is also major importer of chickpea because of more consumption. So there is urgent need to increase the productivity of chickpea. Now a day's higher usage of chemical fertilizer leads to deterioration of soil health. The bio-fertilizers are soil friendly it will provide soil nutrient without deteriorating the soil health. So, Mechanisation is needed for increasing the productivity of chickpea. Efficient seeding depends on accuracy, precision and uniformity of seed placement. Indian farms have been traditionally sown by using manual and bullock drawn seeder. The most popular traditional methods of sowing like broadcasting, line sowing behind the plough. Mechanization improves precision, effectiveness, timeliness of operation and it is economical as well. The physical proprieties of seeds are important factors which determine the design values of metering mechanism. Hence study was undertaken to determine the physical properties of chickpea seed. Davies and Zibokere (2011) determined the some of the physical properties *i.e.*, length, width and thickness. The results revealed that average grain length, width and thickness were 5.49 mm, 5.09 mm and 4.08 mm, respectively. The geometric mean diameter, thousand grain kernel and aspect ratio were 5.02 mm, 87.15 g and 0.95, respectively. Davies (2010) studied the engineering properties of three different varieties of melon seeds and four frictional surfaces were used, namely, glass, plywood, galvanized steel and concrete for determination of static friction and angle of repose and reported that the highest coefficient of friction was observed in concrete surface for all the three varieties of melon investigated. Karaj *et al.* (2010) determined the engineering properties of *Jatropha curcas* seeds. It was reported that coefficient of static friction of seeds was higher on rubber surface and lowest on stainless steel. The coefficient of static friction was observed higher on all surfaces for kernels than for seeds. It was found that angle of repose of kernels was higher than for seeds. Mollazade *et al.* (2009) determined the some of engineering properties of cumin seed. Three surfaces were used for determination of engineering properties *i.e.*, glass, galvanized iron sheet and plywood. It was reported that the static angle of repose (43-49 deg), dynamic angle of repose (47-56.6 deg) and coefficient of static friction on the three surfaces: glass (0.48-0.77), galvanized iron sheet (0.36-0.73), and plywood (0.57-0.69). Seyed *et al.* (2006) studied the engineering properties of water melon

seeds and used three surfaces namely plywood, galvanized metal sheet, glass, fibreglass and rubber. Results showed that the coefficient of friction of watermelon seeds on some materials varied from 0.26 on glass to 0.676 against rubber and angles of repose for three watermelon seeds ranged from 27.092 to 32.38, 21.662 to 28.146, respectively.

2. Materials and Methods

Physical and engineering properties were determined in the laboratory of Division of Agricultural Engineering, IARI New Delhi. The chickpea crop variety BG 1003 was selected for laboratory testing and field experiment. The relevant properties of chickpea seeds were measured for coated and uncoated seeds. Experiments are carried out at two levels namely uncoated seed (S_1) and bio-fertilizer coated seed (S_2). *Rhizobium* bio-fertilizer coating was done taking sugar solution as adhesive for bio-fertilizer. Size of seed in terms of length, breadth and thickness were measured using digital vernier calliper. Twenty seeds were randomly selected from bulk and subjected for size analysis with three replications.

The shape of the chickpea seed was reckoned as roundness and sphericity. The geometric mean diameter (D_g), arithmetic mean diameter (D_a) mm, roundness % and sphericity of the seeds were computed by following equations (Kayode, 1993).

$$D_g = (abc)^{1/3}$$

$$D_a = \frac{(a+b+c)}{3}$$

$$\emptyset = \frac{(abc)^{1/3}}{a}$$

Where

a = Length, b = Breadth and c = Thickness

D_g = Geometric mean diameter,

D_a = Arithmetic mean diameter and

\emptyset = Sphericity

Bulk density of seed was measured by volumetric and weight method. The cylinder of volume 100 ml was filled with seed without compaction and the bulk density was worked out by following expressions. Weight on electronic balance of precision 0.001 g.

$$BD = \frac{W}{V}$$

Where,

BD = Bulk density, g/cm³

W = Weight of seed, g

V = Volume of cylinder, cm³

The apparatus used for measuring dynamic angle of repose, consisted of a funnel with an adjustable throat opening mounted on a stand. A circular plate with four centering arms was mounted in the funnel above the adjustable throat. The funnel was filled with seed by keeping its adjustable throat closed. The throat was fully opened to allow free flow of seed over and around the plate mounted in the funnel. At the end, a heap-cone of the seed was formed on the plate (Altunatasa and Tarihi, 2007). The base diameter and height of cone was measured. The angle of repose was calculated with the following relationship:

$$\theta = \tan^{-1} \left[\frac{2h}{d} \right]$$

Where,

θ = Angle of repose, degrees

h = Height of cone, cm

d = Base diameter, cm

The coefficient of static friction of two surfaces *i.e.*, aluminum and mild steel were measured for the seed by using inclined plane method. The material was kept on a horizontally placed surface and the slope was increased gradually. The angle (α) at impending slide was recorded. The coefficient of static friction was expressed by $\tan\alpha$. The procedure was repeated 20 times and the mean value was calculated. The experiment was conducted for all the levels of test variables as shown in Table 1.

Table 1: Seed properties and levels of test variables

Sl. No.	Properties	Test variables	Levels of test variables
1	Size	Chickpea seeds	S ₁ –Uncoated seed
2	Shape		S ₂ -Bio-fertilizer coated seed
3	Bulk density and True density		
4	Angle of repose		
5	Coefficient of static friction		*Two surfaces

3. Results and discussion

The effect of *Rhizobium* coating on physical and engineering properties of chickpea seed was studied and results are presented in below.

3.1 Physical properties

Table 2: Physical and engineering properties of chickpea seeds

Parameters	Level of test variables	
	Uncoated	Coated
Length (mm)	9.017 ± 0.62	9.065 ± 0.44
Breadth (mm)	7.059±0.69	7.144±0.90
Thickness (mm)	6.57±0.54	6.9±0.22
GMD (mm)	7.324±.45	7.32±0.45
Sphericity (%)	81.6±3.07	82±4.15
Roundness (%)	87.23 ±2.13	87.36±2.72
Bulk density (g/cm³)	0.629±0.02	0.641±0.03
Seed weight (1000)	236.5±2.32	237.25±3.22
Angle of repose	26.9±5.61	22.75±4.9
Coefficient of friction	0.603±0.12	0.576±4.9

3.2 Size of the seed

The size of the seed specified the spatial dimensions are given in Table 3. The mean length, breadth and thickness of uncoated and bio-fertilizer coated chickpea seeds was observed 9.01 ± 0.62 mm, 7.059 ± 0.69 mm, 6.57 ± 0.54 mm and 9.06 ± 0.44 mm, 7.144 ± 0.90 mm, 6.9 ± 0.22 mm, respectively. Both mean length and breadth thickness of coated seeds is slightly higher as compared to uncoated chickpea seed. However, the differences between coated and uncoated were found non-significant. These values are agreement with Tavakoli *et al.* (2009).

3.3 Shape of the seed

The shape of the seed, in terms of roundness and sphericity are presented in Table 2. The sphericity and roundness of the chickpea seed at different levels were found in the range of 82-84 % and 85-87 %, respectively. The roundness and sphericity of uncoated and bio-fertilizers coated chickpea seeds found to be 87.23 ± 2.13 %, 87.36 ± 2.72 % and 81.6 ± 3.07 %, 82 ± 4.15 %, respectively. There is no significant difference was observed in sphericity and roundness for two levels of chickpea seeds but the variations were marginal. These values are agreement with Shahin *et al.* (2006).

3.4 Bulk density and True density of seed

The average bulk density of the seeds for uncoated and bio-fertilizer coated chickpea seeds was observed as 0.629 g/cm³ and 0.641 g/cm³, respectively. The average bulk density of seeds for uncoated and bio-fertilizer coated chickpea as shown in Table 2. The average bulk density of bio fertilizer coated seeds was higher as compared to uncoated seeds. However, it was found statistically non significant. These values are agreed with Pradhana *et al.* (2009).

3.5 Thousand seed weight

The mean value of the thousand seed weight of uncoated and bio-fertilizer coated chickpeas seeds as shown in Table 5. The mean value of the thousand seed weight of uncoated and bio-fertilizer coated chickpeas seeds were found to be 236.65 g and 237.25 g, respectively.

The thousand seed weight of bio-fertiliser was slightly higher than uncoated chickpea seeds. The differences were subtle as statistically non significant.

3.6 Angle of repose and coefficient of static friction

The angle of repose and coefficient of static friction for uncoated and bio fertilizer coated chickpea seeds as shown in Table 4 and 5. The angle of repose for uncoated seed was significant difference with coated seed. The mean value of angle of repose for uncoated and bio fertilizer coated seeds found to be 29.6 and 26.9, respectively. The highest value of angle of repose was observed as 29.6 for uncoated with the mild steel surface. For the aluminium surface, mean values of coefficient of static friction for uncoated and bio-fertilizer coated seeds was observed as 0.60 and 0.392, respectively. The highest value for coefficient of static friction was recorded for mild steel surface for uncoated seed. However, significant difference was observed in angle of repose between uncoated and coated seed. It might be due to change in surface texture of coated seed. Hence, the angle of repose has to be considered for proper designing the hopper to free flow of seed. It imparts that it is necessary to modify hopper of exiting machine for coated seed handling. The mean weight of bio fertilizer coated chickpea seeds slightly increased as compared with uncoated seeds. The highest value of angle of repose was observed as 34 for uncoated seed for mild steel. Therefore, considering the ease and economy of fabrication, the mild steel surface was selected for the experiment.

The statistical analysis was conducted with T-test method in different levels of parameters were used for the experiment as shown in Table 6. The parameters are length, breadth, thickness, geometric mean diameter, 1000 seed weight and sphericity was found to be non significant at 5 per cent level of significance and the angle of repose was found to be significant at 5 per cent level of significance.

Table 3. Size of chickpea seed at level of coated

Seeds	Uncoated	Bio-fertilizer coated
Length (mm)		
Range	8.55-9.75	8.47-9.53
Mean	9.017	9.065

C.V (%)	5.34	3.96
Breadth		
Range	6.36-7.83	6.58-7.89
Mean	7.059	9.065
C.V (%)	7.06	3.96
Thickness		
Range	5.36-7.17	6.58-7.89
Mean	6.57	7.144
C.V (%)	10.20	5.48

Table 4. Engineering properties of chickpea seed

Seeds	Uncoated		Bio fertilizer coated	
Angle of repose	MS	Al	MS	Al
Range	23-34	22-29	23-34	22-28
Mean	29.6	24.4	26.9	24.38
C.V (%)	14.17	10.53	14.17	9.48
Bulk density (g/cc)				
Range	0.595-0.655		0.622-0.678	
Mean	0.629		0.641	
C.V (%)	2.87		2.57	

Note: C.V Coefficient of variation (%)

Table 5. Angle of static friction and 1000 seed weight of uncoated and coated seed.

Seeds	Uncoated	Bio fertilizer coated seed
1000 seed weight(g)		
Range	234.5-239	231-240.52
Mean	236.65	237.254
C.V (%)	0.697	1.17

Angle of static friction	MS	AI	MS	AI
Range	0.344-0.754	0.424-0.674	0.364-0.687	0.249-0.547
Mean	0.603	0.509	0.576	0.392
C.V (%)	19.98	16.21	17.53	27.42

Table 6. ANOVA table for Independent samples test for chickpea seed dimensions

Seed Dimensions	Comparison between treatments	T-Test for Equality of Means			
		t-value	DF	Sig	Std. Error Difference
				(2-trailed)	
length	T ₁ -T ₂	-.253	18	0.803	0.19004
Breadth	T ₁ -T ₂	-.424	18	0.677	0.20055
Thickness	T ₁ -T ₂	-1.570	18	0.134	0.21973
Geometric mean diameter	T ₁ -T ₂	0.000	18	1.000	0.14916
Angle of Repose	T ₁ -T ₂	2.073	18	0.047	2.00146
1000 seed weight	T ₁ -T ₂	-.590	18	0.563	1.02421
Sphericity	T ₁ -T ₂	-.841	18	0.412	1.21936

Note: T₁= Uncoated chickpea seed.

T₂= bio-fertilizer coated chickpea seed.

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