RESEARCH ARTICLE

DESIGN AND DEVELOPMENT OF INCLINED PLATE SEED METERING MECHANISM FOR CHICKPEA INTENSIFICATION

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Abstract: Physical properties of chickpea i.e. average aspect ratio, surface area, bulk density, true density, moisture content and porosity of chickpea were observed 75.54 %, 157.379 mm^2, 709.55 kg/m^3, 875.50 kg/m^3 , 19.81 % and 18.62 % respectively. Mean spacing was found more accurate in 45^o inclination of seed box form horizontal which was 20.03 cm. and average field efficiency and time required for one ha was 63.63% and 0.44 h/ha respectively.

Keywords: Planter, Chickpea, Inclined

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the second-most important pulse crop after pigeon pea in the World for human diet and other use. It is cultivated in area of 13.54 million hectares with a total production of 13.10 million tonnes and average productivity of 967.6 kg/ha (FAO 2013). Chhattisgarh state has good agro-ecological situation for chickpea production. In state it is grown over an area of 356.52 thousand hectares with an annual production of 433.15 thousand tonnes and an average productivity of 1140 kg/ha (Anonymous, 2016). Sowing of chickpea using SCI method developed by IGKV Raipur is done manually which is time consuming, labour intensive and it fails to maintain accurate row to row and plant to plant spacing which directly affects the crop yield and also the cost involved is high. So, inclined plate metering mechanism was developed.

MATERIALS AND METHODS

The inclined plate seed metering mechanism was designed to optimize the cell size of metering plate for picking two seeds per cell.

Physical Characteristics of Chickpea Seeds

Measurement of average length (L), width (W) and thickness (T)

Average length (L), width (W) and thickness (T) is calculated by using the expressions as suggested by Singhal *et al.* (2003).

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

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

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

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

Geometric mean diameter (D_p)

The geometric mean diameter (D_p) 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)

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

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

Aspect Ratio

$$Ra = \frac{W}{L} \times 100$$

Where,
Ra = Aspect ratio, %;
L = Length, mm;
W = Width, mm

SurfaceArea

$$S = \pi \times Dg^2$$

Where,
S = Surface area, mm^2; and
Dg = Geometric mean diameter, mm.

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Mass of chickpea seeds

To obtain the mass, 1000 randomly selected chickpea seeds were weighed by using electronic balance with a least count up to 0.001g.

Design of Seed Metering Mechanism

A metering device draws seed from bulk and delivers them at the desired rates in the seed tubes for sowing in soil, uniformly. Mechanical seed metering devices in planter usually have cells on a moving member to have positive seed metering. Commonly recommended metering systems on planters are horizontal plate, inclined plate, vertical rollers with cells, and cups over the periphery (Anon, 1991). Since chickpea seeds are medium in size and very susceptible to mechanical damages so, the vertical and horizontal plate metering mechanism were not considered. This inclined plate is made of plastic. Size of cell on inclined plate was decided based on the size of the chickpea seeds for which it was prepared.

Design of inclined plate for chickpea seeds

The design of inclined plate was done considering the agronomical requirement of chickpea seed in SCI method. The agronomical requirement for chickpea seed for SCI method include seed rate 40.51 kg/ha, row spacing as 50 cm, plant to plant spacing as 20 cm.

Table 1. Specification of inclined plate

S. No.	Particulars	Specification
1	Inner diameter of plate	130 mm
2	Diameter of plate hole	22 mm
3	Outer diameter of plate	170 mm
4	No. of cell	24
5	No. of hole	1
6	Material of plate	Plastic

lined plate was designed specially for two seeds on per hills.

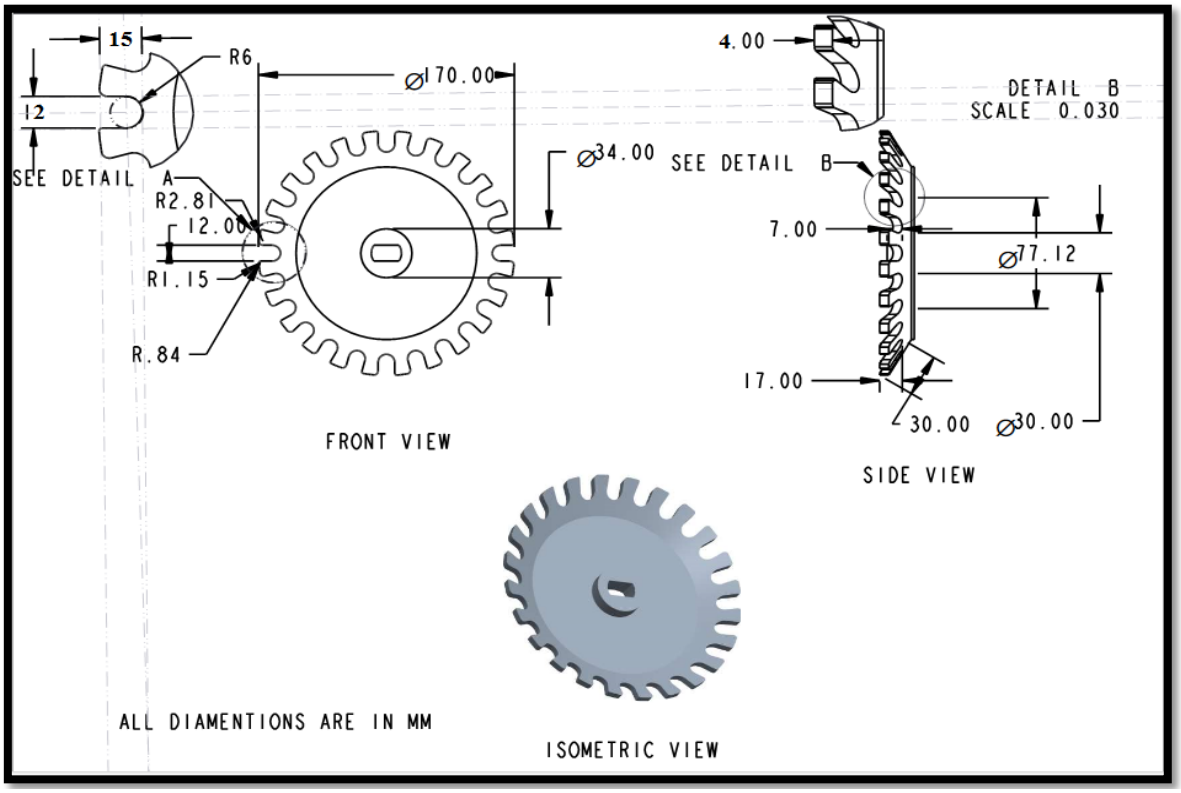

Fig. Details of seed metering plate

Fig. Seed metering plate with two seeds in each cell

Design of cells for metering plate

Volume of some varieties of chickpea (JG 130 and *Vaibhav*) was calculated for design the seed metering plate. Volume of cells was taken as semi-ellipse and calculated by following formula:

$$\text{Volume of cell} = \frac{\pi}{2} \times a \times b \times c$$

Where,

a = semi-major axis, mm

b = semi-minor axis, mm

c = thickness of cell, mm

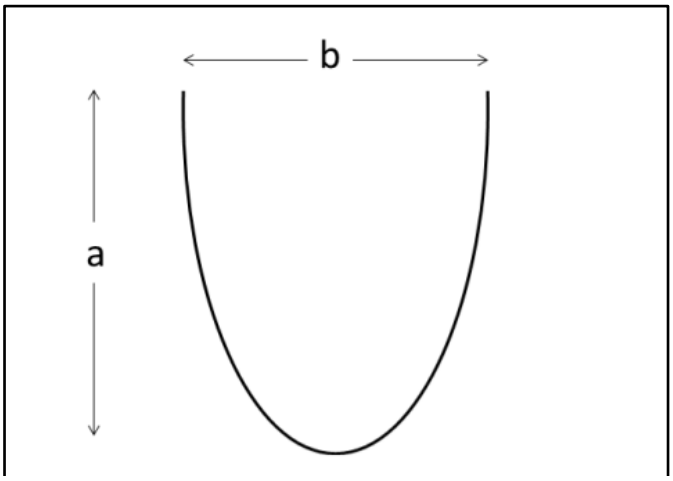

Fig. Area of cell

RESULTS AND DISCUSSION

Average Physical Dimensions of the Chickpea Seeds

The average length, width and thickness were found to be 8.48 mm, 6.45 mm and 6.03 mm respectively. The average Sphericity and geometric mean diameter of chickpeas was calculated 0.81 and 6.90 mm respectively. Average weight of 1000 grain of chickpea seed was observed 244.85 g.

Average aspect ratio, surface area, bulk density, true density, moisture content and porosity of chickpea were observed 75.54 %, 157.379 mm^2, 709.55kg/m^3 ,875.07kg/m^3, 19.81 % and 18.62 % respectively.

Field Performance

Performance of modified inclined plate seed metering mechanism was evaluated in field condition.

Field capacity and field efficiency of the machine

Theoretical field capacity and effective field capacity were determined on the basis of area covered per unit time.

Theoretical field capacity

On the basis of width of furrow and speed, theoretical field capacity was calculated by following formula:

Theoretical field capacity (ha/h) = W ×S/10

Where,

S = Speed of operation i.e. 3.5 km/h

W = Theoretical width covered i.e. 2 m

Theoretical field capacity (ha/h) = $\frac{2\times3.5}{10}$ = 0.7 ha/h

Effective field capacity

Effective field capacity was observed at 100m ×10 m of field, there was 5 observations taken for analysis of effective field capacity. The average field capacity of inclined plate planter was found 0.44 ha/h.

Effective field capacity (ha/h) = A/T

Where,

A = Actual area covered, ha

T = Total time required to cover the area, h

Field efficiency

Some factors like turning loss affect the field efficiency of planter. The theoretical field capacity of the planter was calculated by taking speed of planter 3.5 km/h and effective width of planter 2 m. The average field efficiency of developed inclined plate planter was observed 63.63 %.

Field efficiency (%) = $\frac{\text{actual field capacity}}{\text{theoretical field capacity}}\times 100$

CONCLUSION

The existing implement is capable of planting pigeonpea at a time of two seeds at the rate of average field efficiency and average time required in field condition was 63.63 % and 0.44 h/ha respectively.

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