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Performance evaluation of inclined plate seed metering mechanism for system of chickpea intensification

Shubham Sinha and Ajay Verma

Abstract
Chickpea (*Cicer arietinum* L.) is the second-most important pulse crop after pigeonpea 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). After measurement the 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.in field performance the average speed of operation, field capacity and field efficiency of developed inclined plate planter were observed 3.5 km/h, 0.45 ha and 63.63% respectively. Plant height was found highest in T_1 at 30 DAS, 60 DAS, 90 DAS and at harvest i.e. 20.28 cm, 35.75 cm, 46.00 cm and 58.05 cm respectively followed by T_2, T_4, T_5 and T_3 respectively. Pods per plant were found highest in T_1 i.e.115.27 followed by T_2, T_3, T_5 and T_4 i.e. 113.38, 107.60, 107.11 and 105.62 respectively. Maximum grain yield of chickpea was found in T_1 which was 2826.67 kg/ha and minimum was observed in T_4 i.e. 2317.09 kg/ha. Grain yield of T_1 was found 18.63%, 3.26%, 21.99% and 20.45% greater than the T_2, T_3, T_4 and T_5 respectively. Cost of operation of developed inclined plate planter was calculated ₹ 1228.33 /- per hectare and energy requirement was 590.52 MJ/ha.

Keywords: Chickpea, seeds, intensification

Introduction
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). Generally broadcasting, line sowing behind the plough, dibbling are being practiced for many past year and are still used by many small and marginal farmers. Mechanization in the sowing process aids in timely completion of the field operation increases the field efficiency and economizes cost of cultivation compared to traditional method of sowing. 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, to mechanize and tackle the problem faced above, a planter with suitable metering mechanism can be used.
System of chickpea intensification produced stable yield of 26-28 q/ha which is about 40% higher compared to conventional recommended package of practices. Its seed requirement is 50-55 kg/ha. This technology (SCI) has five components which are applied in a set. These are: 1. Wider spacing (50× 20cm), 2. Sowing of two seeds per hill, 3. Nipping at 30 days after sowing, 4.Aeration and mechanical weeding with small hand tools twice at 18-20 and 40-45 days after sowing is required to keep the field weed free and provides aeration in the root zone. 5. Controlled irrigation : The chickpea crop is needed to irrigate at sowing branching and flower initiation stage. Moderate irrigation (5-6 cm) is requires at sowing and branching (35 DAS) which can be applied through sprinkler or controlled flood. Light irrigation (4.5 cm) is required at flower initiation (55-60 DAS) and it should be given only through sprinkler.

Material and methods: The inclined plate seed metering mechanism was designed to optimize the cell size of metering plate for picking two seeds per cell. The details of the procedure followed in the development of the optimized inclined plate metering mechanism for chickpea seeds is evaluated both in laboratory as well as in the field condition.

Calibration of inclined plate planter
The procedure of testing the planter for correct seed is called calibration of planter. It is necessary to calibrate the machine before putting it in actual use to find out the confirmation of

desired seed rate and fertilizer rate. All the moving components of the machine were lubricated properly. It was then calibrated for Proper seed rate. The step by step procedure shall be as follows:
a) Determine the nominal width of coverage of the drill. The nominal width is equal to the multiplication of the number of furrow openers and the spacing between the openers in cm.

Working width of the planter = N x W

Where:
N = Number of furrow openers in planter
W = Distance between two furrow openers

Example:
4 furrow openers x 50 cm = 2000 cm
= 2.0 m

b) Find the length of a strip, having the nominal width as determined in (a) above, necessary to make one hectare;
Example:

$\frac{10000\ m^2}{2.0\ m}$= 5000 m

c) Determine the number of revolutions the ground wheel has to make to cover the length of the strip determined in (b) above. It is recommended that this should be done by actually operating the drill in the same field and soil conditions as will be used for the field operation test.

Distance covered in 1 revolution of ground wheel = π D m

d) From the value found in (c) above, select a number of revolutions of the ground wheel to cover a convenient fraction of a hectare, say, 1hac. A drill having a nominal width of 2.0 m and ground wheel diameter of 42 cm will require about 3980.8 revolutions to cover 1 hectare.

Formula = $\frac{10000}{\pi \times D \times N \times W}$

e) Calculate revolutions per minute of ground wheel in case of animal drawn drill and revolutions per minute of metering device in case of tractor-drawn drill. The travelling speed for animal drawn drill should be 2.4 km/h and for tractor drawn drill the speed should be 3 and 5 km/h. A 60-cm diameter wheel makes about 21 revolutions per minute when travelling at a speed of 2-4 km/h.
f) Jack up the drill so that the ground wheels turn freely. Make a mark on the drive wheel and a corresponding mark at a convenient place on the body of the drill to help in counting the revolutions of the drive wheel. Practice turning the wheel at the speed calculated in (e) above, if turning has to be done manually for animal-drawn drill.
g) Select the seed = chickpea seeds.
h) Put selected seed and fertilizer in the hopper. Place a sack or container under each boot.
i) Rotate drive wheel at the speed as calculated in (e) above.
J) Weigh the quantity of seed dropped from each opener and record on the data sheet.
k) Calculate the seed dropped in kg/hectare and record on the data sheet.
l) Repeat the process indicated in (h) to (k) at least three times.

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, km/h
W = Theoretical width covered, m
= Number of furrow openers multiplied by distance between the furrow Opener, m

Effective field capacity
The time required for complete sowing was recorded and Effective field capacity was calculated.

Effective field capacity (ha/h) = $\frac{A}{T}$

Where,

A = Actual area covered, ha
T = Total time required to cover the area, h

Field efficiency

$$\text{Field efficiency} = \frac{\text{Actual field capacity}}{\text{Theoretical field capacity}} \times 100$$

Result and Discussion
Calibration of inclined plate planter
Before operating the inclined plate planter in field condition calibration was done in laboratory. Seed rate was minimum at that angle i.e. 40.51 kg/ha followed by 41.25 kg/ha and 41.28 kg/ha at 50^o and 60^o angle of seed box.

Table 1: Physical Properties of different observations

Observations	Aspect ratio, %	Surface area, mm^2	Bulk density, kg/m^3	True density, kg/m^3	Moisture Content, %	Porosity, %
1	80.96	172.49	691.05	860.52	11.3	19.76
2	70.76	154.81	694.04	890.05	20.4	21.91
3	76.83	155.26	712.02	870.04	18.4	18.39
4	71.42	152.62	720.04	885.02	23.1	18.18
5	76.22	172.96	690.02	867.09	22.8	19.76
6	73.77	145.26	714.03	858.32	14.8	15.88
7	67.08	139.34	730.02	872.23	25.6	16.09
8	77.48	165.12	724.08	880.42	18.3	17.61
9	86.58	163.31	690.05	877.06	21.3	20.68
10	74.27	152.62	730.02	890.04	22.1	17.97
average	75.53	157.37	709.55	875.07	19.81	18.62
SD	5.51	11.02	0.01	0.01	4.25	1.92
CV %	30.36	121.65	0.000286	0.000173	18.09	3.69

Table 2: Seed rate at different angle of developed inclined plate planter

Observation	Seed rate at different angle, kg/ha		
	45º	50º	60º
Average	40.51	41.25	41.28
SD	0.24	0.49	0.45
CV %	0.06	0.24	0.21

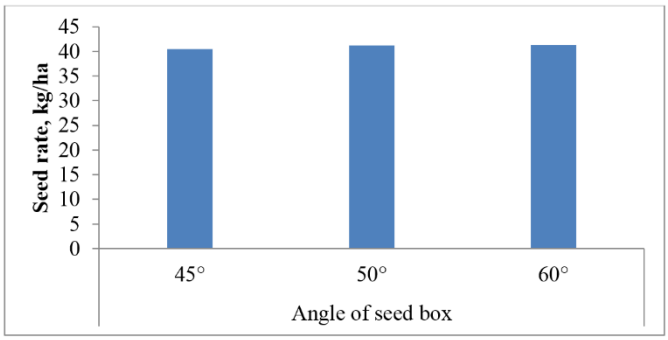

Fig 1: Seed rate Vs Angle of seed box

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) = 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. The time required to complete the sowing operation on 1000 m^2.

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.

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

Conclusion

The existing implement is perform the machine in laboratory as well as field condition of planting chickpea 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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