Indian Research Journal of Extension Education
ISSN: 0972-2181 (Print), 0976-1071 (e-Print)
NAAS Rating : 5.22
Journal homepage: seea.org.in
RESEARCH ARTICLE
https://doi.org/10.54986/irjee/2022/apr_jun/128-134

Design and Development of Manually Operated Single Row Planter for Groundnut Seeds

Uday Veer Singh[1], Sheen Cline Moses[2], Tarun Kumar Maheshwari[3] and Rana Noor Alam[4]

1. Res. Scholar, 2. Prof. & Head, 4. Res. Engineer, Department of Farm Machinery and Power Engineering, VIAET, SHUATS, Prayagraj, UP., 3. Asso. Prof. (Farm Machinery and Power Engineering), B.S. Dr.B.R.A. CAET, Etawah, UP.

Corresponding author e-mail : uday1187@gmail.com

Received on April 02, 2022, Accepted on June 04, 2022 and Published Online on June 20, 2022

ABSTRACT

India is one among the most important producers of oilseeds within the world and occupies a crucial position within the Indian agricultural economy. Groundnut is also called as wonder nut and cashew nut of poor man. Groundnut is one among the foremost important cash crops of our country. Farm mechanization is an important element of agriculture. Mechanization of groundnut farming is an essential input in modern agriculture. The level of farm mechanization in India stands at about 40-45 per cent with states such as UP, Haryana and Punjab having very high mechanization levels, but north-eastern states having negligible mechanization. This level of farm mechanization is still low as compared to the countries such as the U. S. (95%), Brazil (75% and China (57%). While the level of mechanization lags behind other developed countries, it has seen an average agriculture growth rate of 3.56 per cent through the last decade.A single row planter for groundnut seeds, operated by hand, was designed to enhance planting efficiency and reduce drudgery involved in manual planting method of groundnut seed. The major components of the planter are seed hopper, seed metering device, jaw clutch, seed delivery tube, furrow opener, furrow covering wheels and drive wheel. The diameter of seed metering device was found as 11.66 cm and number of cells on the periphery of seed metering device was found as 6. The theoretical volume of designed seed hopper was found as 0.024472 m^3. The overall dimensions of the designed planter were found as 1474 × 960 × 330 mm. The average speed of operation was found as 2.24 km/h during the field testing. The average theoretical field capacity, effective field capacity and field efficiency was found as 0.101 ha/h, 0.081 ha/h and 81.35 per cent respectively. Average seed rate was found as 65.08 kg/ha during the field testing of developed planter. This planter is considered economical with ease of operation, requiring no special skill to operate and can be adopted by the farmers for the planting of groundnut seed.

Key words: *Mechanization; Groundnut planter; Seed hopper; Seed metering device.*

Indian economy is based on agriculture. Development in agriculture results in raise economic status of country. Groundnut seed contain 44-56 per cent oil and 22-30 per cent protein on a dry seed basis and may be a rich source of minerals (*Ingale, S. and. Shrivastava, S. K., 2011*). The level of farm mechanization in India stands at about 40-45 per cent with states such as UP, While the level of mechanization lags behind other developed countries, it has seen an average agriculture growth rate of 3.56 per cent through the last decade (Sectoral paper on Farm Mechanization, 2018). Share of mechanization of field activities in 2016-17 is represented in the following Table 1.

Table 1. Share of mechanization of field activities in 2016-17

Type of operation	Mechanization level (%)
Soil and seed bed preparation	40
Seeding and planting	29
Plant protection	34
Irrigation	37
Harvesting and threshing	60-70 for wheat and rice and < 5 for others

Source: Sectoral paper on Farm Mechanization, 2018

The traditional system also has the limitations of uneven depth of seed placement, delay in covering seeded rows, slow ground coverage, and high labor requirement (100-125 man h/ha for cereals and about 250 man h/ha for groundnut). The availability of a low-cost, easy to use mechanical planter for small-scale farmers could alleviate these problems substantially, and will also help to take care of timely seeding and reduce the farmers' drudgery. (*Awadhwal and Babu, 1994*).

Seed planting machine is a device which helps in the sowing of seeds in the desired position hence assisting the farmers in saving time and money. The basic objective of planting operation is to place the seed in rows at desired depth and spacing, cover the seeds with soil and supply proper compaction over the seed. A farmer may sow at desired seed rate but inter-row and intra-row distribution of seeds are likely to be uneven leading to bunching and gaps within the field. (*Upadhyaya et al., 2017*)

The cost price of imported planters has gone beyond the purchasing power of most of our farmers. This project work focused on the planning and fabrication of a operated by hand planter sowing for various crop seed that's cheap, easily affordable by the agricultural farmers. They concluded that the need of a poor and small land farmer has fulfilled by the manual operated seed planter. The farmers can easily and effectively plant their seed in the field by these planters. (*Khan et al., 2015*).

The timely seeding is important in rain fed farming. Delayed sowing beyond normal window period prolongs growing, causing moisture stress on maturing crops. With the current seeding practices, farmers are unable to sow the crop at appropriate time because the conventional devices are slow in operation, and require high labour cost, thereby increasing cost of production. Mostly unskilled labours drop the seed resulting in gaps and bunching of plants during a row which ends up in non-uniform cropping. The non-uniform cropping creates imbalance in utilization of nutrients and moisture which results in reduction in crop productivity.

Keeping the view to mechanize the farming system of groundnut and to overcome drudgery due to manual dibbling of groundnut, manually operated single row planter was designed and developed for the sowing of groundnut seeds.

METHODOLOGY

The planter for groundnut seeds was designed and developed at the Department of Farm Machinery and Power Engineering, Vaugh Institute of Agricultural Engineering and Technology (VIAET), SHUATS, Naini, Prayagraj, UP. The planning of components of this planter includes Main frame, drive wheel, furrow covering wheel, seed hopper, seed metering device, furrow opener, handle. the planning consideration is described below with following heads:

Design and development of manually operated single row planter:

Design considerations: The design of operated by hand multi-crop planter supported the subsequent considerations.

- The simple fabrication of component parts.
- The safety of the operator.
- The operation of the machine should be simple for little scale or rural farmers.
- The materials available locally were utilized in the fabrication of the all components.
- Availability and price of the materials for construction.
- Easy to work both male and feminine are often operated.
- Easy to operate for both male and female worker.

Main frame : Frame was designed in such a manner that is suitable to bear all possible loads during operation of machine. Angle of size 35 x 35 x 3 mm was used. The 2 piece of 250 mm and 2 pieces of 610 mm were welded on 1 piece of 370 mm. Front width of frame was 193mm. Middle width of frame was 370 mm and rear width was 360mm.

Handle: The handle of a manual groundnut planter was developed and fabricated to push the planter. MS steel circular pipe of 200mm diameter was used for handle. The handle was fastened to the frame. Length of the handle is calculated based on average standing elbow height of operator. So, the average standing elbow height is the 100cm. Distance of wheel centre from the operator (for operator height of 95-105 cm) in operating condition is that the 115 cm. So, the angle of inclination (θ_h) with the horizontal is as

$$\tan\theta_h = \frac{a_1}{a_2}$$

Where, a_1= height of centre of wheel to the elbow (cm), a_2= horizontal distance between the normal to the centre of wheel and normal to the elbow line (cm). The average

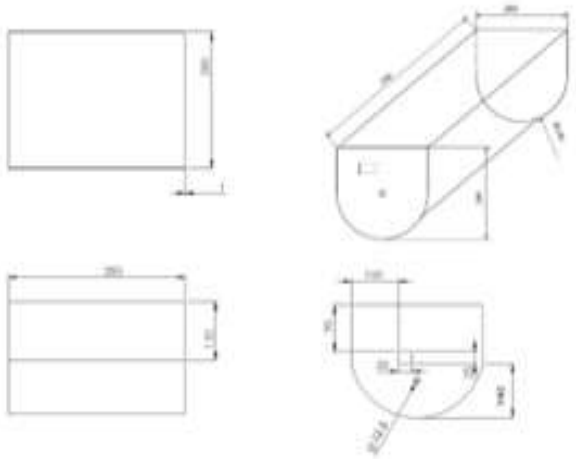

Fig. 1 Developed view of seed hopper of planter

elbow height at standing position of male worker of Allahabad is 98.23 cm. (*Swarn et al., 2014*).

Seed Hopper : A seed amount stored in the seed hopper is determined by its size. A 2 mm M.S. flat sheet was selected for the fabrication of seed hopper and folded in U-shape shown in figure 1. The capacity of seed hopper was 11.13kg, but it maintained 4 to 5 kg groundnut seed for the experimental purpose. Opening of 30×25 mm was provided to discharge the groundnut seed to the seed delivery tube. Overall dimension of seed box was 380×280×260 mm. According to the design consideration, seed hopper was designed and developed.

Seed metering device : Seed metering device is the most important part of the manually operated planter. The seed rate and seed spacing was regulated by metering device. The metering device should have sufficient holes to fall optimum seeds without any overlapping of seed in the soil. At the time of design of the seed metering device the first most important thing is that how many cells is required for correct seed spacing. Now the other thing is that what would be the diameter of the seed metering device. So, the diameter of the seed metering device was calculated by following equation (*Sharma and Mukesh, 2010*)

$$D_m = \frac{V_r}{\pi N_r}$$

The number of cells on the metering device for sowing of groundnut was obtained with the help of following equation (*Sharma and Mukesh, 2010*)

$$\text{No. of cells on periphery of metering device} = \frac{\pi \times D_g}{i \times X}$$

Where, D_g =Diameter of ground wheel (cm),

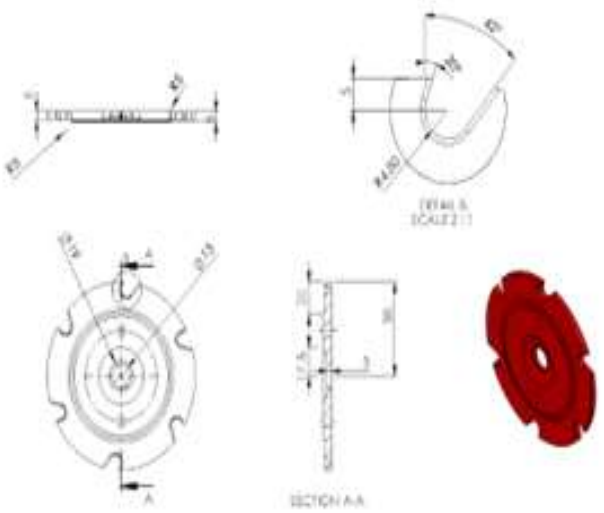

Fig. 2. Developed view of seed metering device with 6 cells

i= speed ratio,

X= plant to plant distance (cm) in groundnut crop.

The speed ratio and plant to plant distance was selected as 1 and 20 cm respectively.

Furrow covering cum press wheel: A set of two inclined wheels made up of MS plate of 1.5mm thick were used for closing the furrow as well as for compressing the soil at seed root zone just after it touches the ground after passing through the dropping seed tube. One pair of press wheel of diameter of 350 mm and width of 70 mm was fabricated.

Adjustable row marker: The adjustable row marker was fabricated in the manual groundnut planter assists the operator in maintaining more exact or consistent row spacing.

Front wheel with lugs: One drive wheel was designed for manual groundnut planter. The 350 mm diameter front wheel was fabricated with lugs on its circumference to enhance grip and prevent slippage during planting. The length, breadth, and thickness of lugs were 60, 10, and 10 mm, respectively. The mild steel flat bar was used as fabrication material.

Power developed by the operator of machine : Power of useful work done by an average human on the drive machine is given by (*Campbell, 1990*)

$$Hp = 0.35 - 0.092 \log t$$

Where, t = operation time in minutes.

Now, on the average a person can work on the sector 2-4 hour's continuous. Hence the power developed by the operator is 0.13 – 0.16 hp. Now if we take working time four hours then the power developed by a human is

HP = 0.35-0.092×log 240=0.35-0.092×1.60=0.13hp

Now we all know that developed power by a sequence drive is:

$$\text{Hp} = \frac{\text{Push Force (kgf)} \times \text{Speed of Machine (m/s)}}{75}$$

The Average operating speed of the machine is 2.0 km/h (0.56 m/s). The push force was calculated as 17.41 kgf by the equation (2.5)

Power transmission system of manually operated planter for groundnut seeds : The planter was operated manually to form it cost effective. Power is transmitted from the transported wheel to the seed metering wheel through pintle chain. Since an influence (hp) transmitted in manual seed planter is extremely low. So, for the amplification of the facility for desired power requirement of seed metering device, a sequence sprocket system was used which have two chain sprockets of multi speed ratio. The chain length is calculated by the following equation (*Sharma and Mukesh, 2010*).

$$\text{m} = \frac{2C}{p} + \frac{Z_1+Z_2}{2} + \frac{Z_2-Z_1}{Znp}$$

Where,

m = number of chain links,

C = centre to centre distance between two sprockets (mm),

P = Chain pitch (mm), Z_1 and Z_2 are the number of teeth in the driver sprocket and driven sprocket respectively.

$$\text{m} = \frac{2\times260}{13} + \frac{14+28}{2} + \frac{(28-14)^2}{2\times3.14\times13}$$

$$= 40+21+2.4=63.4 \approx 63 \text{ links}$$

Length of chain = m×m×p=63×13= 819mm=81.9 cm

Performance evaluation of developed planter : Developed manual planter was tested for its performance in the farm machinery laboratory as well as in the field of 10m×5m size at Agriculture Farm, SHUATS, Prayagraj, UP (Testing code IS., 1971).

Laboratory test : The following test was conducted in the laboratory:

a) Metering Test, Calibration, Seed damage determination test, Uniformity of Seeding.

Field tests : The planter was operated in the field to test the following:

a) Field Operation, Placement, Power Requirement: Field Efficiency and Labour Requirement:
b) Suitability and Soundness of Construction

Procedure for laboratory testing :

Laboratory calibration: The planter was set on flat and levelled surface. Bricks were placed under the frame so that the ground wheels could be rotated freely. The poly bag was tagged at lower end of seed tube for collecting seeds. Drive wheel was marked at one point with chalk and it was rotated for 50 revolutions. The area covered in 50 revolutions of the drive wheel of groundnut planter was calculated theoretically. The quantity of seed collected 50revolutions of drive wheel in tagged bag was weighed on the electronic balance and seed rate was determined as

$$\text{Seed rate } \left(\frac{\text{kg}}{\text{ha}}\right) = \frac{\text{WS} \times \text{NR}}{50 \times 1000}$$

Where:

WS= Weight of collected seed (g) in 50 revolutions

NR= Number of revolutions of drive wheel required to cover one ha

Mechanically damaged seed : A machine was operated in the sand bed, prepared in the farm machinery laboratory, to sow the seed on the sand bed surface. After operation the 50 seeds were picked manually for the observation of visible seed damage. The seeds which were liberated out of seed tube were examined for visible damage. The test was carried out for groundnut seed (*Oduma et al., 2014*).

$$\text{Seed damage \%} = \frac{\text{Total no. of damaged seed}}{\text{Total no. of seeds}} \times 100$$

Seeding uniformity: This test was carried out to ensure the uniformity of metering of the seed. For this the sand bed method was used. An artificial levelled fine sand bed of 25 cm deep and 10 m in length was prepared and width was 1.5 m. The planter was allowed to travel over this bed with furrow openers or seed tubes lowered as near to the top surface of the bed as possible. The number of seeds dropped was observed and average

distance between two seeds was also observed for each meter of bed length. The test was repeated five times.

Field performance evaluation of manual driven single row planter :

Speed of operation: The planter's speed is critical for improved performance during operation. If the speed is higher than the required speed, it causes greater damage to the seeds and reduces seed-to-seed distance in the row; nevertheless, if the pace is lower, the planter's efficiency is automatically reduced. So, for improved performance, regular walking was recommended. To calculate the real speed on the field, two 10 m markers were placed in the field. At least one person was supposed to stand at the first stop point after the planter started operating in order to record how much time it had taken to cross the 10 m distance. Five observations were made, and speed was estimated based on the experimental data recorded. The formula used as

$$\text{Speed of operation, km/h} = \frac{\text{Distance, m} \times 18}{\text{Time, s} \times 5}$$

Theoretical field capacity: The following formula was used to determine theoretical field capacity (*Hossain, M.M., 2014*)

$$\text{Theoretical field capacity} = \frac{W \times S}{10}$$

Where,

W = width of operation, m and

S = speed of operation, km/h

Effective field capacity (*Hossain, M.M., 2014*)

$$\text{Effective field capacity, ha/h} = \frac{A}{T}$$

Where,

A = Actual Field coverage (ha), and

T = Actual time of operation (h)

Field efficiency : The following formula was used to calculate field efficiency (*Sahay, J., 2004*).

$$\text{Field efficiency}(\%) = \frac{\text{Effective field capacity}, \frac{\text{ha}}{\text{h}}}{\text{Theoretical field capacity} \frac{\text{ha}}{\text{h}}} \times 100$$

Plant to plant spacing : After 15 DAS, the plant to plant spacing was measured as shown in figure 2.5 (b). A measuring tape was used to measure the distance between two successive seeds. A similar test was performed five times randomly selected spots.

Plant Populations : The number of plants were count per square meter by using the wooden frame of 1-square meter in the field randomly placing the frame at five times in the selected spot in the experimental field shown in figure 2.5 (c). This experiment was performed after 15 DAS. The plant population per hectare was determined by using the formula:

$$\text{Plant Population/ha} = \text{No. of plants/m}^2 \times 10000$$

Planting depth: After 15 days of seeding, three rows were chosen at random from research plot, and the seedling was picked up from the soil and measured the depth of seed placement by using scale.

RESULTS AND DISCUSSION

A manually operated single row planter for groundnut seed was designed and it's all the components were fabricated and developed in the Farm Machinery Laboratory, Department of Farm Machinery and Power Engineering, VIAET, SHUATS, Prayagraj, U.P.

Design and development of manual operated single row planter: The angle iron, MS sheet and nylon roll was used as fabrication material. The complete model of manually operated single row planter for groundnut seed are shown in the figure: 3.3. The complete specification of developed planter was studied and description is shown in the table 2. On the basis of design considerations, the pushing force for the developed planter was found as 17.41 kgf. The chain and sprocket power transmission system were selected and the length of chain was found as 81.90cm which was used to transmit the power from drive wheel to the seed metering device. Three spiral jaw type clutch

Table 2. Specification of Manually operated single row groundnut planter

Components	Description
Overall Dimension (L×W×H)	1474 mm × 960 mm × 330 mm
Furrow opener	Shovel type (Reversible)
Seed tube	1
Number of furrow opener	1
Seed Metering Device	1 plate of 11.66 cm diameter with 6 cells on its periphery
Drive Wheel	1 wheel of 350 mm diameter
Power Transmission	Chain and sprocket, bevel gear
Gear Ratio	1
Clutch	Jaw type
Press cum furrow covering wheel	2, inclined wheel of 350 mm diameter
Seed Box	1
Bearing and hub	6 and 2
Weight of planter	32 kg
Source of power	1 man

was selected and used in the power train to engage and disengage the power from drive wheel and seed metering device. On the basis of design considerations and assumptions, the seed hopper was designed and developed and capacity of seed hopper was found as 11.13 kg. The seed metering device was designed and developed by using the nylon and the diameter of the seed metering was found as 11.66cm and 6 cells was found on its periphery for seed picking and metering into the soil. The components of the planter such as main frame, seed hopper, seed metering device, jaw clutch, seed delivery tube, furrow opener, power transmission system, furrow covering wheels and drive wheel, were designed and developed in the laboratory. The complete specifications are shown in the Table 2.

Laboratory Testing of Manual Driven Single Row Planer: The developed planter was tested in the Farm Machinery Laboratory, Department of Farm Machinery and Power Engineering, SHUATS, Prayagraj, U.P.

Figure 5 shows the seed rate per hectare which was calibrated in the laboratory. The average seed rate was found as 60.82 kg/ha at quarter fill level of seed hopper. At half fill level of seed hopper, the average seed rate was found as 65.03 kg/ha. At full fill level

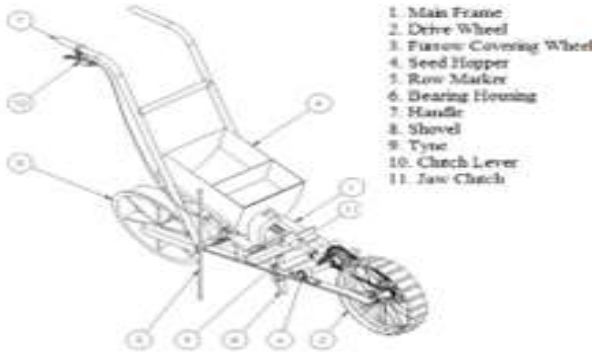

Fig. 3. Labelled diagram of manually operated planter for groundnut seeds

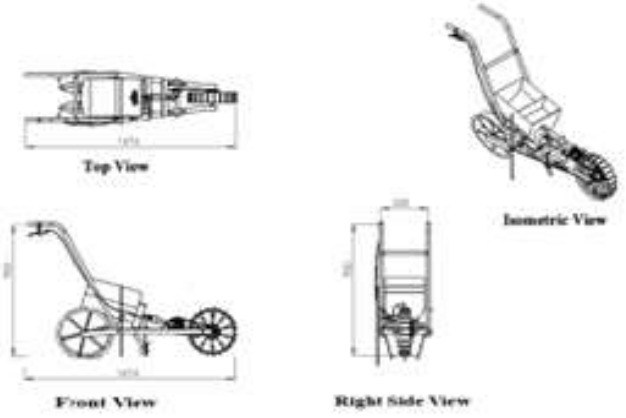

Fig. 4. Isometric, Top, Front and Right view of designed manually operated planter for groundnut seeds

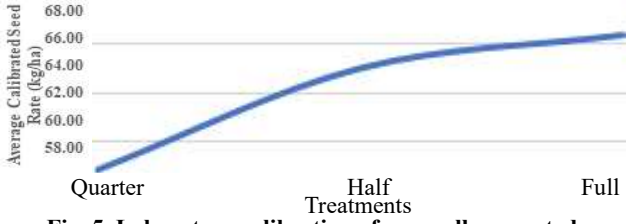

Fig. 5. Laboratory calibration of manually operated single row planter for groundnut seeds

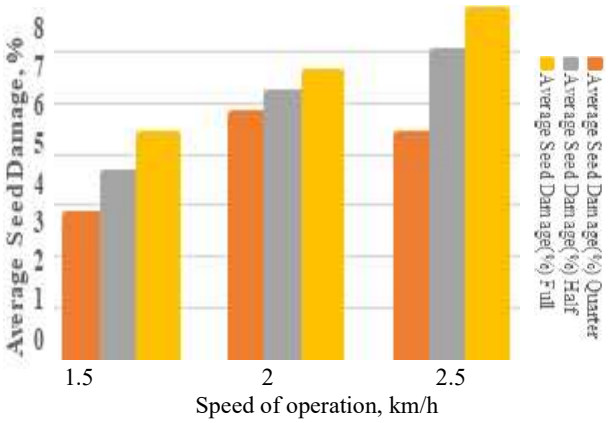

Fig. 6. Uniformity of seed spacing of manually operated single row planter for groundnut seeds

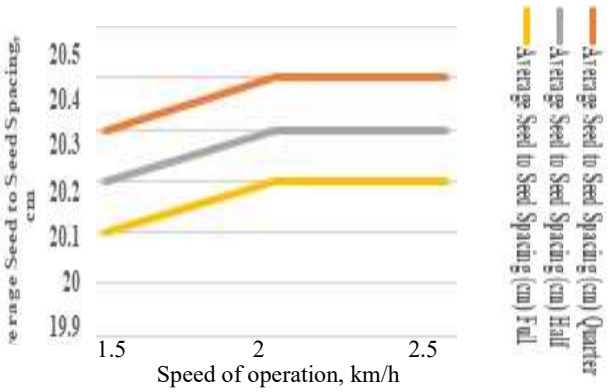

Fig. 7. Uniformity of seed spacing of manually operated single row planter for groundnut seeds

of seed hopper, the average seed to seed spacing was found as 66.40 kg/ha. Figure 6 shows the seed damage percentage which was tested in the laboratory. The average seed damage percentage was found as 2.8, 4.8 and 4.4 per cent at quarter fill level of seed hopper and at speed of 1.5, 2.0, and 2.5 kmph respectively. At half fill level of seed hopper, the average seed damage percentage was found as 3.6, 5.2 and 6.0 per cent at a speed of 1.5, 2.0, and 2.5 kmph respectively. At full fill level of seed hopper, the average seed damage percentage was found as 4.4, 5.6 and 6.8 per cent at a speed of 1.5, 2.0, and 2.5 kmph respectively. Figure 7 shows the uniformity of seed spacing was tested by the sand bed method in the laboratory. The average seed to seed spacing was found as 20.1cm, 20.2cm and

20.2cm at full fill level of seed hopper and at speed of 1.5, 2.0, and 2.5 kmph respectively. At half fill level of seed hopper, the average seed to seed spacing was found as 20.2, 20.3 and 20.3 cm at a speed of 1.5, 2.0, and 2.5 kmph respectively. At quarter fill level of seed hopper, the average seed to seed spacing was found as 20.3, 20.4 and 20.4 cm at a speed of 1.5, 2.0, and 2.5 kmph respectively.

Field performance evaluation of manual driven single row planer : The developed planter was tested in the Agriculture Farm, SHUATS, Prayagraj, U.P. The size of experimental field was marked as 10 m×5 m for the sowing operation by developed single row planter for groundnut seeds. Table 3 shows the average, standard deviation and coefficient of variation of different parameters of groundnut planter during operation.

Table 3. Field performance parameters of manually operated single row planter

Particulars	Average	SD	CV (%)
Speed of operation, km/h	2.24	0.34	15.33
Theoretical field capacity, ha/h	0.101	0.01	13.71
Effective field capacity, ha/h	0.081	0.002	1.89
Field efficiency, per cent	81.35	10.09	12.40
Row to row spacing, cm	45	-	-
Plant to plant spacing, cm	20.8	0.84	4.02
Plant population/ha	114000	11401.75	10.00
Seed rate, kg/ha	65.08	1.75	2.69
Seed placement depth, cm	4.1	0.42	10.20

CONCLUSION

The different components of the planter were designed and assembled successfully. Seed metering device was designed with six cells on its periphery and the diameter of seed metering device was 11.66 cm. The seed hopper was designed and its theoretical volume and capacity was found 0.024472 m^3 and 11.13 kg respectively.The overall dimensions of the designed planter were found as 1474 × 960 × 330 mm. The average speed of operation was found as 2.24 km/h during the field testing. The average theoretical field capacity, effective field capacity and field efficiency was found as 0.101 ha/h, 0.081 ha/h and 81.35 per cent respectively. Average seed rate was found as 65.08 kg/ha during the field testing of developed planter.It is concluded that the planter can easily be operated for the sowing of groundnut seeds.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

REFERENCES

Awadhwal, N. K., and Babu, M. M. (1994). A multi-row bullock drawn planter for groundnut and some other dryland crops. *Intl.Agril.Engg. J.*, **3**(1-2) : 69-76.

Campbell, J. K. (1990). Dibble sticks, donkeys, and diesels: Machines in crop production. published by International. Rice Research Institutes (IRRI), Manila, Philippines.

Farm Sector Policy Department NABARD. (2018). Sectoral paper on farm mechanisation, NABARD, Head Office Mumbai.

Hossain, M. M. (2014). Development and Evaluation of Low Cost Seeder for Maize Establishment, M.Sc. Thesis. Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh.

Indian Standard (1971). Test code for seed-cum fertilizer drill. IS: 6316-1971. Bureau of Indian Standards, New Delhi.

Ingale, S., and Shrivastava, S. K. (2011). Nutritional study new variety of groundnut (Arachis hypogaea L.) JL-24 seeds. *African J. Food Sci.*, **5** (8) : 490-498.

Kalay, K.; Moses, S.C., and Ashok, K. (2015). A survey on the design, fabrication and utilization of different crops planter. *Eur. Acad. Res,* **3***,* 147-158.

Khan, K.; Moses, S.C., and Kumar, A. (2015). The design and fabrication of a manually operated single row multi-crops planter. *IOSR J. Agri. Vet. Sci.*, **8**(10), 147-158.

Lata, Swarn and Parvez, Razia (2014). Application of anthropometry measurement in designing ergo-friendly work station for the elderly, The Allahabad Farmers, LXX (1), 161-171.

Oduma, O.; Ede, J. C., and Igwe, J. E. (2014). Development and performance evaluation of a manually operated cowpea precision planter. *International Journal of Engineering and Technology*, 4(12), 693-699.

Sahay, J. (2004). Elements of Agricultural Engineering. Standard Publishers Distributors.

Sharma, D. N., and Mukesh, S. (2010). Farm Machinery Design: Principles and Problems. Publisher: Jain brothers.

Upadhyaya, Suraj V; Vijaya Vittala; Gowda, G; Poojith, M B; Vikranth Kumar K (2017). A review on agricultural seed sowing, *International Journal of Innovative Research in Science, Engineering and Technology*, **6** (4), 7216-7223.

• • • • •