Indian Journal of Agricultural Sciences **91** (10): 1443–6, October 2021/Article
https://doi.org/10.56093/ijas.v91i10.117424

Seed metering device evaluation by Grease Belt Method

DEVESH KUMAR[1], ASHOK TRIPATHI[2], OM PRAKASH[3], PRATIBHA JOSHI[3*], KALAY KHAN[4] and MANISH KUMAR[1]

ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110 012, India

Received: 15 October 2018; Accepted: 03 March 2021

ABSTRACT

Soybean [*Glycine max.* (L.) Merr.] serve as one of the most valuable crop in the world; not only for oil purpose it also feed for livestock and aquaculture. A simple laboratory grease belt method for soybean planter was developed for testing and calibrating the seed metering mechanism. The study was conducted in the year 2017, in the Department of Farm Machinery and Power Engineering, Allahabad. The main frame consists of variable speed drive, and grease coated belt that are fitted with necessary provisions. The second frame consists of seed hopper and seed metering unit. The field and laboratory methods have been developed and used for evaluation of planter performance, each method having its own advantages and shortcomings. In the present study, grease belt was used for laboratory evaluation of wheel type seed-metering device and investigated the feeding quality, missing index, seed rate, and uniformity of seeds in the row at various speed of grease belt. The results from grease belt methods were in good agreement and analysis of variances showed that seed-metering device with 18 cells in 50 rpm performed better than seed-metering device with 32 cells and in other speeds. Calibration of the manually operated seed-cum-fertilizer soybean planter has been done in the laboratory. During calibration of planter, it found that there was less missing of soybean due to circular shape of seed. Due to full hopper the pressure was high at the bottom and due to this force on seed of soybean easily reaches at the metering device.

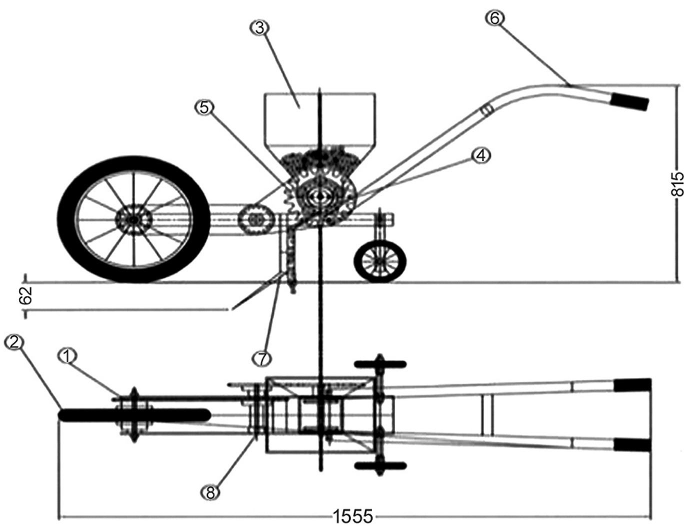
Keywords: Grease belt, Hopper levels, Laboratory test, Seed metering mechanism, Soybean planter

The amount of seeds planted along the rows and distance uniformity between seeds are important factors in crop production which can affect uniform crop growth and yield. There are several techniques for determining the planter performance (Jasa *et al.* 1982, Brooks and Church 1987, Kachman and Smith 1995, Karayel *et al.* 2005). The protein content in soybean [*Glycine max* (L.) Merr.] seed is approximately 40% and the oil content is approximately 20%. This crop has the highest portion content and the light gross output of vegetable oil among the cultivated crops in the world. In 2007 the total cultivated area of soybean in the world was 90.19 million ha and the total production was 220.50 million tonnes (FAO 2009). The world soybean production increased by 4.6% annually from 1961–2007 and reached average annual production of 217.6 million tonnes in 2005-07. World production of soybeans is predicted to increase by 2.2% annually to 371.3 million tonnes by 2030 using an exponential smoothing model with a damped trend. The agricultural mechanization is the application of machinery, technology and increased power to agriculture, largely as a means to enhance the productivity of human labour and often to achieve results well beyond the capacity of human labour. The adoption of agricultural innovation in developing countries attracts considerable attention because it can provide the basis for increasing production and income. Small scale farmers' decisions to adopt or reject agricultural technologies depend on them. The traditional planting method is tedious, causing fatigue and backache due to the longer hours required for careful hand metering of seeds if crowding or bunching is to be avoided according to Bamgboye and Mofolasayo (2006). The importance of machine in agricultural operations in the world today should never be underestimated, be it manually operated or powered (Sam and Okokon 2013). One of the major problems confronting the peasant farmers in India is in the area of planting seeds because of the limited economy.

MATERIALS AND METHODS

An experiment was conducted (2017) at Vaugh Institute of Agricultural Engineering Technology & Science, Sam Higginbottom University of Agriculture, Technology

Present address: [1]Bihar Agricultural University, Sabour Bhagalpur, Bihar; [2]Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh; [3]ICAR-Indian Agricultural Research Institute, New Delhi; [4]Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Srinagar, Kashmir. *Corresponding author e-mail: pratijosh12@gmail.com.



TOP AND FRONT VIEW OF SOYABEAN SEED-CUM FERTILIZER PLANTAR

1	Main Frane
2	Ground Wheel
3	Seed & Farti. Boxes
4	Seed Distributor
5	Sprocket (Big)
6	Handle
7	Furrow Opener
8	Sprocket and Bearning Assl.

ALL DIMENSION IN MM.

Fig 1 Front and side view of seed-cum-fertilizer soybean planter.

and Sciences, Prayagraj. A view to obtain by soybean crop seed-cum fertilizer planter parameters suitable for the development of the manually operated planter, the methodologies were used for the development and laboratory performance evaluation of the manually operated planter has been discussed (Fig 1).

Seed metering mechanism: Seed metering mechanism is a major component in a planter, i.e. it is the heart of the planter because seed rate depend on the types of seed metering device used in planter. It picks required number of seeds and delivers them into the soil through the chute at required depths created by furrow openers. Therefore the design must consider the size of the seed, the intra and inter row spacing for each seed, which usually differs from one crop to another, and for different desired plant populations and for different geographical locations and according to Murray *et al.* (2006). The diameter and numb1er of cells was determined on the basis of mean size of individual seeds, recommended inter-row spacing of seeds and economical and efficient size diameter of driving wheel. Two same metering wheels were used to handle the seeds of soybean crops. Wheel diameter was 102 mm. The diameter of the ground wheel was 177 mm. The seed metering wheel is the most important part of the planter. The seed rate was adjusted by metering wheel. The metering wheel should have sufficient holes to drop optimum seeds without any overlapping of seed in the seedbed. At the time of design of the seed metering wheel the first most important thing is that how many cells are required for correct seed spacing.

Diameter of the seed metering wheel was calculated as (Sharma and Mukesh 2013);

$$Dm = Vr/\pi Nr$$

where, D_m, Diameter of seed metering wheel; cm Vr, Peripheral velocity of seed metering wheel in m/min; N_r, rpm of seed metering wheel.

Number of cell in metering wheel (Sharma and Mukesh 2013).

No. of cells in seed metering wheel = π × diameter of drive wheel, cm/drive ratio × plant spacing, cm

Working principles of the seed metering mechanism: The seed metering mechanism of the planter was designed in such a way that each cell drop a single seed in the grease belt from the seed hopper. Cell rotate along with a seed and travels towards seed tube and drop on belt in addition to gravity, the seeds are pushed out from the cell deliver in the seed tube (Sharma *et al.* 2020). Since, all the seeds are released from the same exit point due to the action of the seed device, the exit path of the seeds from the seed metering mechanism are assumed to be uniform thus improving the uniformity of seed spacing.

Laboratory test: The planter was calibrated in the laboratory to determine the rate of discharge, evenness of seed spacing in rows, missing index and seed damage (%), theoretical field capacity, ha/h and seed germination test. At the time of calibration the hopper of the planter was fully loaded with soybean seeds and fertilizer. The planter was jacked up to allow for free rotation of the drive or transport wheel. A mark was made on the wheels to indicate the reference point to count the number of revolutions when turned, and a polythene bag was placed on the discharge tube to collect the seeds discharged. The drive wheels were rotated 100 times at low speed. A stop clock was used to measure the time taken to complete the revolutions. The seeds in the polythene bag were weighed on a balance and the procedure was repeated 10 times.

Uniformity of seed spacing: Sticky layer of grease to the belt to facilitate the proper embedding of seeds without any displacement to determine the uniformity of seed spacing, i.e. seed to seed spacing of dropped seed in row a by planter, the planter was loaded with seed and fertilizer at different level of hopper. Mount the planter on a stand and allow a 10 m long with 40 cm wide grease belt to travel under the furrow openers or seed tubes at different forward speed, i.e. 2.0 2.5 3.0 km/hr and measured the seed to seed spacing in the row with measuring tape (Oduma *et al.* 2014).

Evaluation of the seed metering mechanism: The developed seed metering mechanism along with a seed hopper were fitted on a grease belt testing unit. Performance of the seed metering mechanism having seed-cum-fertilizer planter were evaluated at three speeds of operation relative to 2.0, 2.5 and 2.30 km/h forward travel speed of a planter. Five replications were conducted for each experiment. In

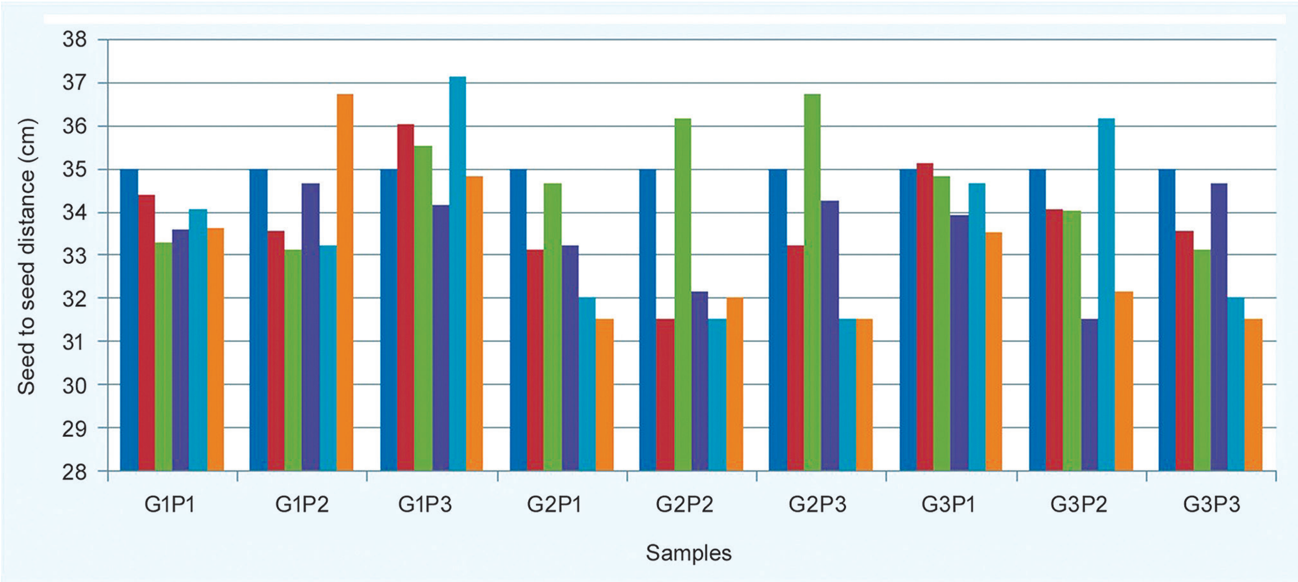


Fig 2 Variation of seed to seed distance of dropped seeds by soybean planter.

each replication, 50 seed spacing and broken seeds delivered from the seed metering unit were recorded.

RESULTS AND DISCUSSION

The interaction between forward speed of planter during laboratory test and hopper filling level was also completed and its calculated values were greater than its table value, calculating thereby significant effect of interaction between planter and hopper. The significant results so critical difference for planter and hopper were also obtained which are given as, CD (5%) for planter (a) SE (m) =277.33 (b) CD (5%) = 564.65. CD (5%) for the hopper (a) SE (m) = 277.33, (b) CD (5%) = 264.65. Since the average value due to planter P_3 is highest (34.07) as compared to the average value of planter P_2 and P_1. So planter P_3 can be regarded as best it also suitable for P_2 and P_1. The average value of 3 planters are given as descending order as P_1= (33.69) > P_3= (34.07) > P_2= (33.42). The average seed germinations due to hopper G_1 are highest. So it can be considered being as most effective hopper. The mean value due to 3 hoppers are given in descending order as G_3 (33.65) > G_1 (34.53) > G_2 (33.0) (Table 1). It was found that germination percentage of the soybean seed has not any significant effect due the replication but it has significant effect due to hopper and speed interaction at 377.13 levels. Similar findings were found by various authors, The average length, width, thickness and geometric mean diameter of the soybean seed were 6.95 mm, 6.02 mm, 4.52 mm and 6.20 mm respectively. The maximum length of the seed was 7.42 mm and minimum was 5.99 mm, maximum width of the seed was 6.45 mm and minimum was 5.01 mm, maximum thickness of the seed was 4.60 mm and minimum was 4.01 mm, maximum geometric mean diameter of seed was 6.55 mm and minimum was 5.50 mm. soybean planter was operated in two types of soil for the crop soybean at speed of 2.0, 2.5- 3.0 km/h (Fig 2). The performance was based on the lab test and field test. From the result, optimal value of study variables was recommended for manually operated soybean planter. The economics of manually operated planter was also calculated.

The maximum length of the seed was 7.42 mm and minimum 5.99 mm, maximum width of the seed was 6.45 mm and minimum 5.01 mm, maximum thickness of the seed was 4.60 mm and minimum 4.01 mm, maximum geometric mean diameter of seed was 6.55 mm and minimum 5.50 mm.

The need of a poor and small land farmer has been fulfilled by the manual operated seed-cum-soybean planter and they can easily and effectively plant their seed in the field by these planters. In the present study, grease belt was used for laboratory evaluation of wheel type seed-metering device performance, indices such as, planting, feeding quality, missing index, seed rate, and different speed, planting and seed space uniformity being the major criteria. To validate the results from more conventional the grease-belt method was used. The results from grease belt

Table 1 Description of different filling level and speed of planter during laboratory test for developed wheel type seed metering device.

Sample	Description of the filling level of hopper and speed
G1P1	Full hopper level + Planter speed at 2.0 km/h
G1P2	Full hopper level + Planter speed at 2.5 km/h
G1P3	Full hopper level + Planter speed at 3.0 km/h
G2P1	Half hopper level + Planter speed at 2.0 km/h
G2P2	Half hopper level + Planter speed at 2.5 km/h
G2P3	Half hopper level + Planter speed at 3.0 km/h
G3P1	Quarter hopper level + Planter speed at 2.0 km/h
G3P2	Quarter hopper level + Planter speed at 2.5 km/h
G3P3	Quarter hopper level + Planter speed at 3.0 km/h

method were in good agreement and analysis of variances showed that the seed-metering device with 18 cells in 50 rpm performed better than seed-metering device with 32 cells and in other speeds. Comparison of the number of spaces that cell in normal domain in different seed-metering speeds (G1P1, G2P2 and G3P3), i,e. 2.0, 2.5 and 3.0 km/hr than grease-belt method. During Calibration of planter, it was found that there was less missing of soybean due to circular shape of seed. Due to full hopper the pressure was high at the bottom and due to this force on seed of soybean easily reaches at the metering device.

REFERENCES

Adekoya Buchel. 1987. Development a cam activated precision punch planter transnational. *Journal of Science and Technology.*

Adekanye, Adesoye T, Akande and Mary A. 2015. Development and evaluation of a manual multi-crop planter for peasant farmers elixir agriculture **86**: Retrieved from website: 'http://www.elixirpublishers.com/#abstract_72.

Altuntas E, Ozgoz E, Taser O F and Tekelioglu O. 2006. Assessment of different types furrow openers using a full automatic planter. *Asian Journal of Plant Sciences* **5**: 537–54.

Anantachar, M Kumar P G V and Guruswamy T. 2010. Neural network prediction of performance parameters of an inclined plate seed metering device and its reverse mapping for the determination of optimum design and operational parameters. *Computers and Electronics in Agriculture* **72**(2): 87–98.

Bamgboye A I and Mofolasayo A S. 2006. Performance evaluation of a two-row okra planter. *Agricultural Engineering International:* the CIGR e-journal **8**(7). Manuscript PM 06002.

Brooks D and Church B. 1987. Drill performance assessments: Changed approach. *British Sugar Beet Review* **50**(3): 13–15.

Duke S H, L E Schrader and G M Miller. 1977. Low temperature effects on soybean mitochondrial respiration and several dehydrogenates during imbibitions and germination. *Plant Physiology* **60**: 716–22.

Ferriss R S, R E Stuckey, M L Gleason and M R Siegel. 1987. Effects of seed quality, seed treatment, soil source, and initial soil moisture on soybean seedling performance. *Physiopathology* **77**: 140–48.

FAO. 2009. Food security and agricultural mitigation in developing countries: options for capturing Synergies. Rome, Italy. www.fao.org/docrep/012/i1318e/i1318e00.pdf.

Gathala M K, Ladha J K, Kumar V, Saharawat Y S, Kumar V, Sharma P K, Sharma S and Pathak H. 2011. Tillage and crop establishment affects sustainability of South Asian rice–wheat system. *Agronomy Journal* **103**: 961–71.

Gupta R K and Sayre K D. 2007. Conservation agriculture in South Asia. *Journal of Agriculture Science* **145**: 207–14.

Gardner F P, R B Pearch and R L Mitchell. 1985. Seed and germination. (*In*) *Physiology of Crop Plants*, p 327. Gardner *et al.* (Eds). Iowa State University Press.

Giménez J P, Elías J Mongiardini, M Julia Althabegoiti, Julieta Covelli, J Ignacio Quelas, Silvina L, López-García and Aníbal R Lodeiro. 2009. Soybean lectin enhances biofilm formation by *Bradyrhizobium japonicum* in the absence of plants, *International Journal of Microbiology*, 2.

Hongxin I A, Lifeng L, G Lulu F and Shifa T. 2015. Study on multi-size seed-metering device for vertical plate soybean precision planter. *International Journal Agriculture and Biology Engineering* **8**(1): 1–8.

Jasa P J and Dickey E C. 1982. Tillage factors affecting corn seed spacing, trans. *American Society of Agricultural Engineering* **25**(6): 1516–19.

Khan K, Moses S C and Kumar A. 2015. The design and fabrication of a manually operated single row multi-crops planter. *IOSR Journal of Agriculture and Veterinary Science* **8**: 147–58.

Kumar A. 1984. Design and fabrication of manually operated single row planter, M Sc (Agricultural Engineering) thesis, Allahabad Agricultural Institute, Allahabad, UP, (India).

Kachman S D and Smith J A. 1995. Alternative measures of accuracy in plant spacing for planters using single seed metering. *Trans. American Society of Agricultural Engineering* **38**(2): 379–87.

Karayel D, Wiesehoff M, Özmerzi A and Müller J. 2005. Laboratory measurement of seed drill seed spacing and velocity of fall of seeds using high-speed camera systems. *Computer and Electronics in Agriculture* **50**(2): 89–96.

Leela C and M Saravana kumar. 2019. Development of electronic metering experimental test rig for maize, *International journal of current Microbiology and Applied Sciences*, **8**(8).

Mehta C R, Chandel N S, Senthil kumar T and Singh K K. 2014. Trends of agricultural mechanization in India, trends of agricultural mechanization in India CSAM Policy brief. 2-3.

Murray J R, N Tullberg J and Basnet B B. 2006. Planters and their components; types, attributes, functional requirements, classification and description. Australian centre for International Agricultural Research (ACIAR) monograph-page no. 120–22.

Olajide and Manuwa. 2014. Design, fabrication and testing of a low-cost row-crop planter for peasant farmers. Proceedings of the International Soil Tillage Research Organization (ISTRO). Nigeria Symposium, Nov-, 3 - 6, Akure, Nigeria, pp. 94–100.

Oduma O, P C Eze and S N Onuoha. 2014. A survey of farm machinery utilization and maintenance in Ebonyi State, Nigeria. *Journal of Experimental Research* **2**(1): 18–25.

Pradhan S C and Ghosal M K. 2012. Design modifications of cup in cup feed metering seed drill for seed pattern characteristics study of paddy seeds. *Engineering and Technology in India* **3**: 7–12.

Sharma D N and Mukesh S. 2013. *Farm Machinery Design*, 3rd edn. Jain Brothers, New Delhi, India.

Sharma P T and K N Dewangan. 2020. Design and comparative performance of shapes of positive seed knocking devices for a vertical plate seed metering mechanism. *Indian Journal of Hill Farming* **33**(1): 164–70

Sam and Okoon. 2013. Comparative chemotaxonomic investigations on *Physalis angulata* Linn. and *Physalis micrantha* Linn.(Solanaceace). *Asian Journal of Applied Sciences* **1**(5): 220–28.