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Performance Evaluation of Manually Operated Multi-Crop Planter for Okra

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Abstract
A manually operated multi crop planter was evaluated for its performance in laboratory and field test. The parameters under study in laboratory test was calibration test, seed germination test seed damage test, uniformity of intra-row seed spacing, while the field test examined the field efficiency, field capacity, draft, hills populations, missing hills and average seed spacing within the row. The average amount of seed in fifty revolutions of drive wheel was observed 14.70 g during calibration. The planter metered out one seeds per discharge at average planting depth of 3 cm with minimum seed damage of 2 % during operation. It has a field efficiency of 89.83% and field capacity of 0.11 ha/hr with an average planting depth and spacing of 3 cm and 18.76 cm respectively.

Keywords: Okra, field efficiency, field capacity, manually operated multi crop planter and seed germination test.

Introduction

Traditional method of sowing is not suitable for growing the crop. The result is very low production. There are many faults such as not proper seed rate, fertilizer rate, seed spacing, problem in inter cultivation and consume more time. 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. There are three sources of farm power utilized for these tools, machines and equipment, manual and animal draft, and motorized power. Mechanization also includes irrigation system, food processing and related technologies and equipment.

Manual method of seed planting, results in low seed placement, spacing efficiencies and serious back ache for the farmer which limits the size of field that can be planted. The cost price of imported planters has gone beyond the purchasing power of most of our farmers. Peasant farmers can do much to increase food production especially grains, if drudgery can be reduced or totally removed from their planting operations. To achieve the best performance from a seed planter, the above limits are to be optimized by proper design and selection of the components required on the machine to suit the needs of crops. This project work focused on the design and fabrication of a manually operated planter sowing for different crop seed that is cheap, easily affordable by the rural farmers, easy to maintain and less laborious to use. The multi-crop planter has the capability of delivering the seeds precisely with uniform depth in the furrow, and also with uniform spacing between the seeds (Khan *et al.*, 2015).

Bamgboye and Mofolasayo (2006) [1, 16, 17] developed a manually operated two-row Okra planter. The field efficiency and field capacity were 71.75% and 0.36 ha/hr while seed rate was 0.36kg/hr with low average seed damage of 3.51%. Gupta and Herwanto (1992) [41] designed and fabricate a direct paddy seeder to match a two-wheel tractor. The machine had a field capacity of about 0.5 ha/hr at a forward speed of 0.81mls, and there was no damage caused by the metering mechanism for soaked seeds; though 3% damage was recorded for pre-germinated seeds. Molin and D' Agostin (1996) [57, 58] developed a rolling planter for stony conditions, using 12 spades radially arranged with cam activated doors and a plate seed meter. Performance evaluation showed important improvement in the planting operation with reduction in human effort, more accurate stands and high field capacity. Kumar *et al*. (1986) [50, 51] developed a manually operated seeding attachment for animal drawn cultivator. The seed rate was 43.2kg/hr while the field capacity was 0.282 ha/hr. Test revealed minimal seed damage with good performance for wheat and barly. Ladeinde and Verma (1994) [53] compared the performance of three different models of Jab planters with the traditional method of planting. In terms of field capacity and labour requirement, there was not much difference between the traditional planting method and the Jab planters. However, backache and fatigue were substantially reduced while using the planters.

Most of our farmers especially in the rural areas and small scale farmers use matchet or sticks to sow different seeds. This matchet or sticks is used to open the soil as the farmer drops the required numbers of seed (often times more than they require numbers are dropped) and then covers them up. This method of planting is labour-intensive and can benefit considerably from simple mechanization (Bamiro *et al.*, 1986) [19, 20].

Farm mechanization is the use of mechanical wheels or systems to replace human muscle in all forms and at any level of sophistication in agricultural production, processing storage and so on in order to reduce tedium and drudgery, improve timeliness and efficiency of various farm operations, bring more land under cultivation, preserve the quality of agricultural produce, provide better rural living condition and markedly advance the economic growth of the rural sector (Anazodo, 1986) [11, 12].

2. Materials and Method

The experimental studies were carried out at the Department of Farm Machinery and Power Engineering, Vaugh School of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India.

Parameters under Study

Laboratory Test

1. Calibration of manually operated planter
2. Seed germination test
3. Mechanically damaged test
4. Uniformity test
5. Missing rate

Field test

1. Draft
2. Hill to hill spacing
3. Hill populations
4. Missing hills
5. Field capacity
6. Field efficiency

Laboratory Test

Calibration: The planter was suspended on a voice and turning the drive wheels rotates the metering wheel. A paint mark was made on the drive wheel to act as a reference point to count the number of revolutions when turned, and a bag was placed on the discharge tube to collect the seeds discharged. The drive wheels were rotated 50 times at low speed. A stop clock was used to measure the time taken to complete the revolutions. The seed in the bag were weighed on a balance and the procedure was repeated five times. Similar test was carried out for each crop seed (Olajide and Manuwa, 2014).

Seed germination test

Seed germination test was done in seed germinator in the laboratory of Department of Genetics and Plant Breeding SHUATS, Allahabad. Laboratory germination tests were normally conducted at different temperature for different seeds. Count out 100 seeds (including damaged ones) and sow in 10 rows of 10 seeds, the rows make it easier to count seedlings. Seeds should be sown at normal seeding depth of 2-3 cm in seed germinator. Place the seeds on top of the sand or soil and push them in with a piece of dowel or a pencil and cover with a little more sand.

$$SG\ (\%) = \frac{GS}{TS} \times 100$$

Where,
SG = seed germination percentage.
GS = germinated seed in seed germinator.
TS = total seed (Including damage seed).

Mechanically damaged test: The seeds discharged from the seed tube were observed for any external damage. Similar test was carried out for each crop seed (Oduma *et al*., 2014) [60]

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

Uniformity test: To determine the uniformity of seed spacing (Seed to seed spacing in row) of manually operated multi-crop planter, the planter was fully loaded with seed. A 10 m thin layer of grease layer was laid out on the plain ground and the machine was run at walking speed of approximately 2.5 km/hr. A measuring steel tape was used to measure the distance between seed to seed in the row. This process was repeated five times and measurement of distance between seed to seed was recorded. (Oduma *et al*., 2014) [60]

Missing rate: During operation operator and one observer counted the number of seeds missed to drop into the seed tube. Then determined the actual number of seeds drop in experimental area if no missing occurred. Then missing rate is determined by the following equation (Oduma *et al*., 2014) [60].

$$\text{Percent missing rate} = \frac{N}{M} \times 100$$

where,
N = number of seeds missing during pickup by metering wheel into seed tube
M = number of seed dropped by the metering wheel if no missing occurred and not more than one seed per cell.

Field test

Draft

The draft requirement of different working component of the planter was studied in order to determined power losses. The planter was run on a well prepared uniform seedbed under optimum soil condition. It is the horizontal component of the pull, parallel to the line of motion. The draft was calculated by the following equation. (J. Sahay, 2004)

$$D = P \cos\theta$$

where,
D = draft, kg
P = pull, kg
θ = Angle between line of pull and horizontal.

Hills Populations

To ensure adequate plant stand in research plots, a higher seed rate is used at sowing and excess plants are later removed to maintain the required plant population. It is therefore necessary to know the spacing between plants within the row and also the number of plants to be maintained in a given length of row. The hill populations was calculated by following formula (Hossain, 2014) [42, 43]

$$\text{Hill Populations/ha} = \frac{10{,}000}{\text{Inter row spacing} \times \text{Plant to plant spacing}}$$

Missing hills

Observations for missing hills were taken after twenty days of planting operation. The total number of missing hill was counted separately for one row in a 10 m distance. These observations were repeated five times for each crop seed. Similar test was carried out for each crop seed. The total percentage of missing hills was calculated by following method (Hossain, 2014) [42, 43]

$$\text{Missing hill \%} = \frac{\text{Actual number of missing hill in 10 m}}{\text{Theoretical number of hill to be planted in 10 m}} \times 100$$

Theoretical field capacity

The Theoretical field capacity was determined by considering the width of coverage of planter and its average operating speed. Similar test was carried out for each crop. Theoretical field capacity was calculated by following formula (Hossain, 2014) [42, 43]

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

where,
W = width of operation, m
S = speed of operation, km/hr

Effective field capacity (Hossain, 2014) [42, 43]

$$C_{eff} = \frac{A}{T}$$

where,
A = Field coverage, ha
T = Actual time of operation, hr

Field efficiency

Field efficiency represents the ratio of effective field capacity to theoretical field capacity and was expressed as percentage. The field capacity was calculated by following formula (J. Sahay, 2004)

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

3. Results and Discussions

Calibration of the manually operated multi-crop planter for okra seeds have been done in the farm machinery and power engineering laboratory VSAET, SHUATS Allahabad; which have been presented in figure. The dropped seeds in 50 r.p.m. of ground wheel were observed 14.85, 15.15, 14.35, 14.42 and 14.7 for replications 1,2,3,4 and 5 respectively and found that there was 2% of missing during calibration test. The average amount of seed in fifty revolutions of drive wheel was observed 14.70 g.

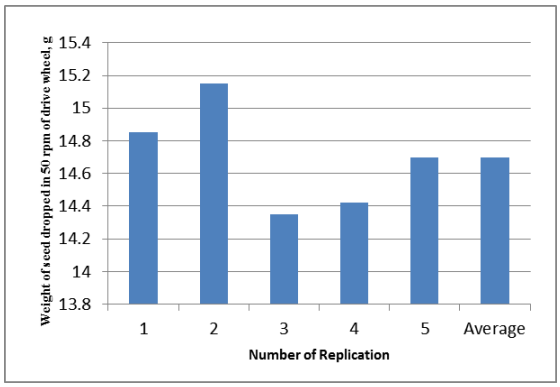

Fig 3.1: Calibrated Seed rate of Manually Operated Multi-Crop Planter of Okra.

Seed germination test: The results of the metered seed germination percentage in five samples were found 86, 84, 84, 85 and 83 % for replication 1,2,3,4 and 5 respectively. The reduction in the germination percentage was due to the immatureness of okra seeds as well as partly and fully damaged seeds. Rahman (2014) Germination percentages for inclined plate seed metering device were found as 92.59%, 96%, 88%, 92.31%, 92.59%, and 92.31%. For fluted type seed metering device, germination percentages were found as 86.21%, 86.36%, 91.30%, 88.46%, 89.47%, and 94.44%.

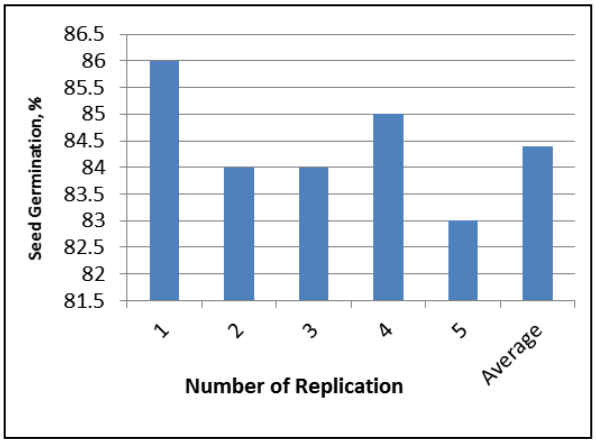

Fig 3.2: Seed Germination Percentage of Metered Seeds of Okra

Seed damage test: The mechanically damaged seeds have been presented in the figure and variation of seed damaged percentage were 3, 2, 1, 3 and 1 for replications 1,2,3,4 and 5 respectively, The average percentage of the mechanically damaged seeds for okra seed was found 2.00%. Its difference was significance at 5 % level. The damage is very low as compared to Oduma, *et. al* (2014) [60] average percentage of seed damage incurred during operation. It is observable from the table that the percentage average damage is 2.34%. Mechanically damaged seeds of okra and pigeon pea were less compared to maize because shape and size of seeds of maize was not round.

Uniformity test: The standard seed to seed distance of okra was 20 cm and row to row distance was 90 cm. We observed that the planter should have to plant 50 seeds but due to missing seeds it planted less that was planted seed by the planter was varying from 44 to 48 seeds and seed to seed distances were varying from 17 to 40cm. The averaged seed to seed distance was found as 20.86 cm which is similar to standard seed distance. Its difference was significance at 5 % level

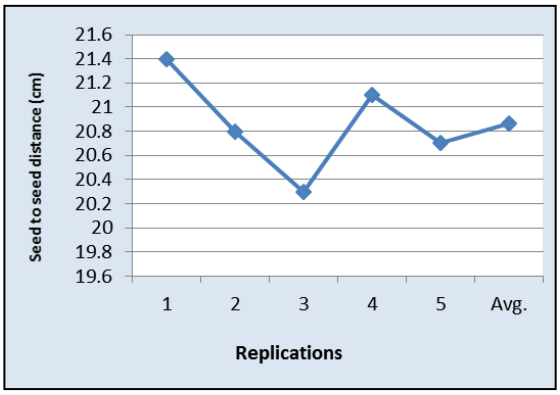

Fig 3.3: Variation of Seed to Seed Distance of Seeds Dropped of Okra on Grease Layer

Missing rate: The missing rate was 0%, 4%, 0%, 2% and, 2% for observations 1, 2, 3, 4 and, 5 respectively. The average missing rate was 1.6%. We observed less missing percentage compared to maize, pigeon pea and red gram due to shape and size of seeds. (Tsegaye, 2015) the highest percent seed miss index of 13.50, 14.35, and 9.92% were recorded with maize, haricot bean and sorghum seeds, respectively. It was non - significant at 5 % level.

Field test

Draft: The manually operated multi-crop planter required less power to push in sandy loam soil compared to clay soil during performance test. It was observed that 13.3 kg pushing force and 0.093 Dbhp. When the pushing angle was increased then the draft force automatically decreased. It was significant in sandy loam soil and clay soil at 5 % level. (Hossain, 2014) [42, 43] calculated similar 10 kg pushing force or 0.044 kW drawbar power for developed maize seeder and 8.5 kg pushing force or 0.037 kW drawbar power for modified maize seeder was observed during the performance test. `

Hill to hill spacing: The average distance of hill to hill was 19.10, 18.20, 18.30, 20.10 and 18.10 cm for observation 1, 2, 3, 4 and 5 respectively whereas the recommended distance was 20 cm. The average distance of dropped seeds of five replications was 18.76, which was similar to recommended distance. The planter should have to plant 50 seeds but due to missing hills and slipping of the drive wheel it planted less that was planted hill by the planter was varying from 45 to 49 seeds and hill to hill distances were varying from 15cm to 40 cm. From the table, it was observed that the distance of hill to hill varies since the metering wheel was not uniformly rotated and changes in speed of the machine. Some of the seeds were trapped in between the seed hopper and the metering wheel due to its circular face shape. it was non-significant at 5 % level due to replications.

Hill Populations: hills populations of okra in sandy loam soil and clay soil respectively. The recommended average hill populations of okra in sandy loam soil and clay soil should have 50 hills in every row. But Actual average hills populations was 41.4 and 41 hills in sandy loam soil and clay soil respectively. The overall theoretical hills population according to plant to plant spacing and row to row spacing in one hectare in both soils was found 111111 hills. But due to hills missing actual hills populations in one hectare in sandy loam soil and clay soil were 92000 and 91112 hills respectively. Observed data have been presented in figure.

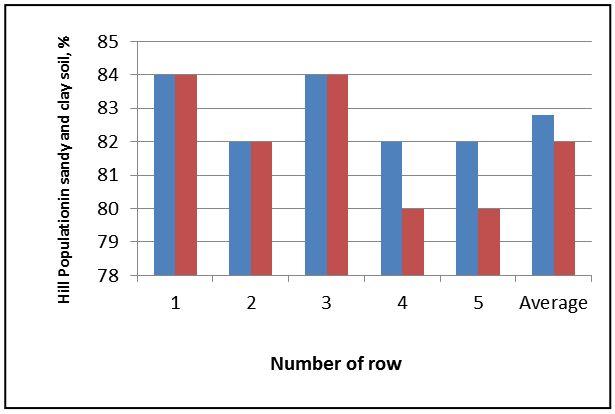

Fig 3.4 Graphical Representation of Percentage of Hill Populations of Okra Crop in sandy and Clay soil.

Missing Hills: The average missing rate in sandy loam soil was 16, 18, 16, 18, and 18 % for observation 1, 2, 3, 4 and 5 respectively and the average missing rate in five observations was 17.2 %. The average missing rate in clay soil was 16, 18, 16, 20, and 20 % for observation 1, 2, 3, 4 and 5 respectively and the average missing rate in five observations was 18 %. Firstly we observed that missing rate increase with increase forward speed of the manually operated planter. Secondly we observed that insufficient moisture content increase missing rate. Thirdly we observed that outer factor also affected on missing rate such as animals and birds. In all the replications we were observed highest missing hill percentage in okra field test in clay soil compare to sandy loam soil.

Field capacity: The theoretical field capacity of the planter was defined as the area covered by the planter in unit time (hour). So for the measurement of the effective field capacity, the area covered by the planter in one row for a particular crop and in particular time has been calculated. Then measurement of the all area covered in one hour has been calculated. The effective field capacity was 0.11 ha/h. It was non-significant at 5 % level.

Field efficiency: We observed that due to increase of speed of the planter and row to row distance so field efficiency, percentage of the damaged seed also increased and also affected on hill spacing. So we found that speed should be manageable for operation in the field. It was approximately 2.5 – 2.8 km/hr in field. The field efficiency of planter was 89.83%.

Conclusion

The following conclusions are drawn on the basis on its performance of the manually operated multi crop planter It has a field efficiency of 89.83%. and operates at a field capacity of 0.11 ha/hr with an average planting depth and spacing of 3 cm and 18.76 cm respectively. The planter metered one seed per discharge with minimum damage of the seeds. The manually operated multi-crop planter required less power to push in sandy loam soil compared to clay soil during performance test. It was observed that 13.3 kg pushing force and 0.093 Dbhp while average horse power of human is 0.1 hp. When the pushing angle was increased then the draft force automatically decreased. It observed that both male and female can be operated because handle is adjustable, they set according to own height.

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