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Research Article

Performance Evaluation of Tractor Drawn Multi-Crop Planter

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ABSTRACT

Sowing is one of the very crucial operation in crop production. Seed drills and planters are commonly used for sowing. Use of multi-crop planter for sowing of various field crops has many advantages over the use of traditional seed drill. For validation and updation of planter technology, it is necessary to evaluate the performance multi-crop planter for sowing of different crops in the field. Hence, in present research work, field trials of multi-crop planter were conducted on the JNKVV farm and on the farmer's field at nine different locations in total 10.20 ha area of Jabalpur district for sowing of the gram, soybean and wheat crops. The results of laboratory calibration of planter for soybean, wheat and gram was found the internal in injury of seed after calibration was in the range of 0.45 - 0.85 per cent. The results of field trials indicated that the field capacity of planter was 0.79, 0.55 and 0.75 ha/h for soybean, wheat and gram crop respectively. Field efficiency of multi-crop planter found were 82, 84 and 80 per cent for soybean, wheat and gram crop respectively. The variation in quantity of seeds dropped from different seed tubes was 5 to 6 per cent. Planter gave the fairly uniform row to row and plant to plant distance. The average speed of operation under the vertisol soil (between 13.6 to 14.4% of soil moisture) was in the range of 3.4 - 3.8 kmph. There was 17-20 % seed saving as compare to traditional seed drill. The overall performance of the tractor drawn multi-crop planter for sowing of wheat, gram and soybean was found to be satisfactory.

Keywords: *Seed drill, Planter, Multi-crop planter, Field capacity, Field efficiency*

INTRODUCTION

Sowing is one of the most important operations in crop production. The time and method of sowing decisively influence the germination and hence production. Sowing at optimum depth and time is essential which will affect the yield of the crop. Sowing in late season will decrease yield about 35%. With the present day advanced agronomic technologies, seed genetics and on- farm technology to deliver optimal yield while using fewer resources, precision planting is not out of place.

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There are different methods of sowing, *viz.* broadcasting, dibbling, drilling and planting. Broadcasting is spreading seeds with hands on the field. It requires larger amount of seed and distribution of seed will not be uniform. In manual seeding with conventional practice, the higher and non-uniform plant population adversely affect grain yield of different crops. Dibbling is placing the seed in the holes made by machine or human. Drilling includes placing the seeds continuously behind the plough with the help of seed drill. With seed drill row to row spacing of seeds can be obtained but plant to plant spacing is not achieved. For better aeration and better fertilizer, pesticide utilization plant to plant spacing is also to be maintained. This can be achieved with the use of planters. Use of the multi-crop planter machine will saves lot of time, labour required, seeds and money as compared to traditional seed cum fertilizer drills. In tractor drawn seed drills, which drops the seed continuously in furrows, row to row spacing can be adjusted but it is difficult to maintain plant to plant distance within the row. This problem can be solved to much extent by using the multi-crop planter (inclined plate) in place of commercially available seed cum fertilizers drills. With the use of multi-crop planter it is possible to obtain optimum plant population per unit area with less quantity of seed as the row to row and plant to plant spacing can be maintained.

In India, most of the farmers uses traditional methods for sowing such as broad casting and seed dropping behind the plough due to undulating topography, small land holdings and higher cost of equipment, which effects germination due to non-uniform placement of seeds at proper depth. Precision and timely sowing are essential for getting good plant stand, higher yield and optimum utilization of rainfall and reduction in the incidence of pests and diseases. Also, due to fragmented and small land holdings and variable farmer typology, it is neither affordable nor advisable to purchase many machines for the planting of different crops by the same farmer. The multi-crop planter can plant different crops with variable seed size, seed rate, depth, spacing etc., effectively and economically. The multi-crop planters have precise seed metering system using inclined plate type seed metering devices which is suitable for different seeds size and spacing for various crops.Although many planters having different seed metering mechanisms i.e. inclined plate, cup feed type and roller with cells on periphery for the application of single seed at a time has been developed, their performance is not up to the mark due to non-performance in obtaining required spacing for irregular shaped seed crops like Paddy, Maize, Black gram etc.

Considering the above facts, it is very crucial to conduct maximum trials of commercially available tractor drawn multi crop planter for its performance evaluation on farmers field as per BIS test code. Thus, the research work has been carried out for performance evaluation of tractor drawn multi-crop planter with the objectives to evaluate the performance of tractor drawn multicrop planterunder field condition and to check the suitability of machine for sowing of different crops.

MATERIALS AND METHODS

The multi-crop planter was evaluated for planting of wheat, gram and soybean crops in vertisol soils after tillage operations at the Farmers field and Research farm of the JNKVV, Jabalpur during the year 2019-20. A field experiment was planned to evaluate the planting of wheat, gram and soybean crops using tractor drawn multi-crop planters in vertisol.

Constructional features of the multi-crop planter

The planter consists of the main frame (2300x660) mm of the unit was made by using a mild steel channel section of size (70x70) mm. the seed hopper, fertilizer box and speed reduction unit were mounted on the main frame. Three-point hitch assembly was provided on the frame so as to hitch the unit to prime mover. The ground wheel diameter 380 mm was fabricated using (50x12) mm wide mild steel flat and it was mounted in the right

side of the frame. Twelve lugs (35x90) mm were provided on its periphery for reducing the slippage during the operation. Two depth wheels without lugs were provided to left and right side of the frame. A power transmission assembly made of chain and sprockets was used to transmit the drive from ground wheel to seed and fertilizer metering units/shafts. The power (for seed metering) was transmitted in two stages, first from ground wheel to speed reduction unit and then from speed reduction unit in seed metering drive shaft. For fertilizer metering the power is transmitted in single stage i.e. farm ground wheel to fertilizer metering drive shafts. The speed ratio of ground wheel to fertilizer metering shaft was 2.3:1, while ground wheel to the seed metering unit, it can be varied as 2.15:1, 3.1:1 and 4.5:1 as per requirements. The chain and sprockets are mounted between the ground wheels and counter shaft at the right side of the main frame with suitable frameworks.

A tractor drawn 9-row multi-crop planter (PAU design) was used to sow wheat gram and soybean crop. The trapezoidal shaped seed box frame is fabricated using M.S. sheet and its rear side was fitted with inclined cell plates at proper spacing. Around the cell plates, circular box made from M.S. Sheet were provided for cotton seed metering purpose. Three types of inclined cell plate with twenty, eight & four (as per requirement) U shape cell cut around its periphery at uniform distance are provided. The drive of the inclined cell plate is given by the main drive shaft through the bend gear set. The trapezoidal shaped fertilizer box with cross section (upper side 1830 x 240 mm, lower 1830x120 and 240 mm deep) was made from 20-gauge black sheet. The fertilizer metering mechanism (vertical cell type roller) was fitted at the bottom of fertilizer box. The depth of planting can be adjusted by varying the height of gauge wheels from the ground level with the help of suitable mechanism provided. Table1 shows the specifications of machine.

Table 1. Specifications of tractor drawn multi-crop planter

Name of machine	Multi-crop Planter
Make	National Agro. Industries
Model	NPS
Weight	290 kg
No of rows	9
Row to row spacing	20 cm standard & adjustable
Seed dropping	Rotating disc with cell on its periphery
Fertilizer metering	Agitator and sliding orifice type

Field preparation

For proper placement of seed and good germination of seed it is very essential to prepare the field which has good tilt. The cultivator and rotavator equipment were used for performing secondary tillage operations and seed bed preparation. For more smoothening of field surface, one planking operation was also done.

Procedure for evaluation of multi-crop planter

The multi-crop planter was evaluated in the field as per BIS test codes (Fig. 1). The specifications of multi-crop planter were recorded and given in above table. The calibration of planter was carried out after adjusting row spacing in the laboratory. As per the recommended seed rate for soybean,

wheat, gram etc. crops, the plates were selected and fixed in seed box. During field trials the observations were recorded for plant to spacing, depth of sowing, seed placement, seed damage, missing hills, seed rate, field capacity etc.

Fig.1. View of multi-crop planter during field trial for performance evaluation.

Determination of performance Parameters

1. Seed germination test

Seed germination test was done in seed germinator in the laboratory of university. 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. seed germination percentage was calculated by using formula

$$SG\ (\%) = (GS/TS) \times 100$$

Where,

SG = Seed germination percentage.

GS = Germinated seed in seed germinator.

TS = Total seed (Including damage seed).

2. 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.

Seed damage (%) = (Total no. of damaged seed / total no. seeds) x 100

3. Missing hills percentage

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.

Percent missing rate = (N / M) x 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.

4. Theoretical field capacity (TFC)

The theoretical field capacity was calculated using the relationship.

TFC = (W x S) / 10

Where,

TFC= theoretical field capacity, ha/h

W= Width of equipment, m

S= Speed of operation, km/h

5. Effective field capacity (EFC)

The actual field capacity was calculated using the relationship given below

EFC = (W x L) / (T X 10000)

Where,

EFC= theoretical field capacity, ha/h

W= Width of field coverage, m

L= Length of field coverage, m

T= Time for covering area, hours

6. Field efficiency (FE)

The field efficiency is the ratio of effective field capacity (ha/h) to the theoretical field capacity (ha/h).

FE = (EFC / TFC) x 100

Where,

TFC= Theoretical field capacity, ha/h

EFC= Theoretical field capacity, ha/h

FE= Field efficiency, %

7. Fuel consumption

For fuel consumption an auxiliary tank of capacity 3 liters having the marking of 50 ml apart is used. The auxiliary tank was connected to the intake and over flow fuel line. The decrement in the level of the fuel, area covered and time of operation was recorded after each treatment.

RESULT AND DISCUSSION

The multi-crop planter was demonstrated for the soybean, wheat and gram crops at university farms and farmers' fields during the year 2019-20. The verities used during the field trial of multi-crop planter were JS 9752,JW 322, JG 3822 of soybean, wheat and gram respectively. The average speed of operation under the vertisol soil (between 13.6 to 14.4% of soil moisture) was in the range of 3.4 - 3.8 kmph while conducting the trials in filed. Width of operation of tractor drawn multi-crop planter was kept 2.3 m for all three crops.

The results of laboratory calibration of planter for soybean, wheat and gram was found the internal in injury of seed after calibration and it was found 0.85%, 0.45% and 0.75 % for soybean, wheat and gram respectively. It is in the range of 0.45 - 0.85 per cent which is in the permissible range. As per as field emergence is concern, No. of plants/meter length was found 6-7,6-7 & 7-8 for soybean, wheat and gram crops respectively. The variation in quantity of seeds dropped from different seed pipes found were 5%,6% and 5%for soybean, wheat and gram crops respectively. So, variation in seed dropping was in range 5 to 6 per cent.

The row to row spacing used was 0.30 cm, 0.20 cm and 0.30 cm for soybean, wheat and gram crops respectively which is as per agronomic requirement of crop. The plant to plant spacing achieved by multi-crop planter found were 15-20 cm, 5-18 cm, 16-20 cm for soybean, wheat and gram crops respectively.Average depth of sowing while operating the machine in field found were 3-5 cm, 4-5c m, 4-5c m for soybean, wheat and gram crops respectively.Seed rate achieved by planter machine found were 62 Kg/ha,56 Kg/ha,71 Kg/ha for soybean, wheat and gram crops respectively

The results of field trials indicated that the field capacity of planter found were 0.79, 0.55 and 0.75 ha/h for soybean, wheat and gram crop respectively. Comparative effective field capacity obtained for different crops in field has shown in Fig.2. Field efficiency of multi-crop planter found were 82, 84 and 80 per cent for soybean, wheat and gram crop respectively. Comparative field efficiencies obtained for different crops in field has shown in Fig.3. So, the results depicted that planter can be satisfactorily used for sowing of soybean, wheat and gram crops.

By using the planter for sowing seed saving found were 18%,15%, 20% for soybean, wheat and gram crops respectively so seed saving varies in the range of 15-20%. Missing hillsfound were 3.5%,3.2%,3.6%for

soybean, wheat and gram crops respectively. Fuel consumption found were 3.8 l/h, 3.7 l/h and 3.8 l/h for soybean, wheat and gram crops respectively. Labour requirement found were 4 man-h/ha for all three crops soybean, wheat and gram crops. Cost of operation calculated were Rs. 1099/h, Rs. 49/h, Rs. 1020/h for soybean, wheat and gram crops respectively. Cost of operation found were Rs. 1380/ha, Rs. 1340/ha, Rs. 1350/ha for soybean, wheat and gram crops respectively with the planter. The comparative performance of the tractor drawn multi-crop planter for soybean, wheat and gram crops are shown in Table 2.

Table 2. Performance data in field testing of multi-crop planter

Sr. No	Particulars	Performance values of machine		
1	Crop	Soybean	Wheat	Gram
2	Date of sowing	02/08/2020	20/11/20	26/11/20
3	Location	Farmers field	JNKVV field	JNKVV field
4	Variety of crop	JS 9752	JW 322, JG 63	JG 3822
5	Field emergence, No. of plants/meter length	6 - 7	6-7	7- 8
6	Width of operation, m	2.3	2.3	2.3
7	Seed rate, Kg/ha	62	56	71
8	Row to row spacing, m	0.30	0.20	0.30
9	Plant to Plant spacing, cm	15 to 18	5-8	16 to 20
10	Speed of operation, Km/h	3.6	3.7	3.5
11	Depth of sowing, cm	3-5	4-5	4 -5
12	Internal damage to seed (%)	0.85	0.45	0.75
13	Theoretical Field Capacity (TFC), ha/h	0.972	0.666	0.945
14	Actual Field Capacity (AFC), ha/h	0.797	0.559	0.756
15	Field Efficiency (FE), %	82	84	80
16	Fuel consumption, l/h	3.8	3.7	3.8
17	Missing hills, %	3.5	3.2	3.6
18	Variation in seed dropping (%)	5	6	5
19	Labour requirement man-h/ha	4	4	4
20	Seed saving, %	18	15	20
21	Cost of operation, Rs/h	1099	749	1020
22	Cost of operation, Rs/ha	1380	1340	1350

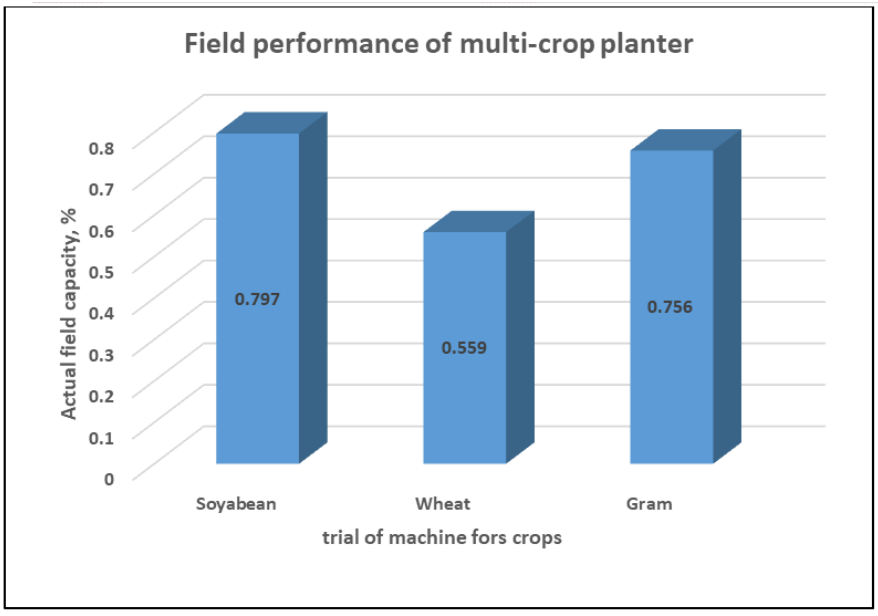

Fig. 2. Effective field capacity of multi-crop planters

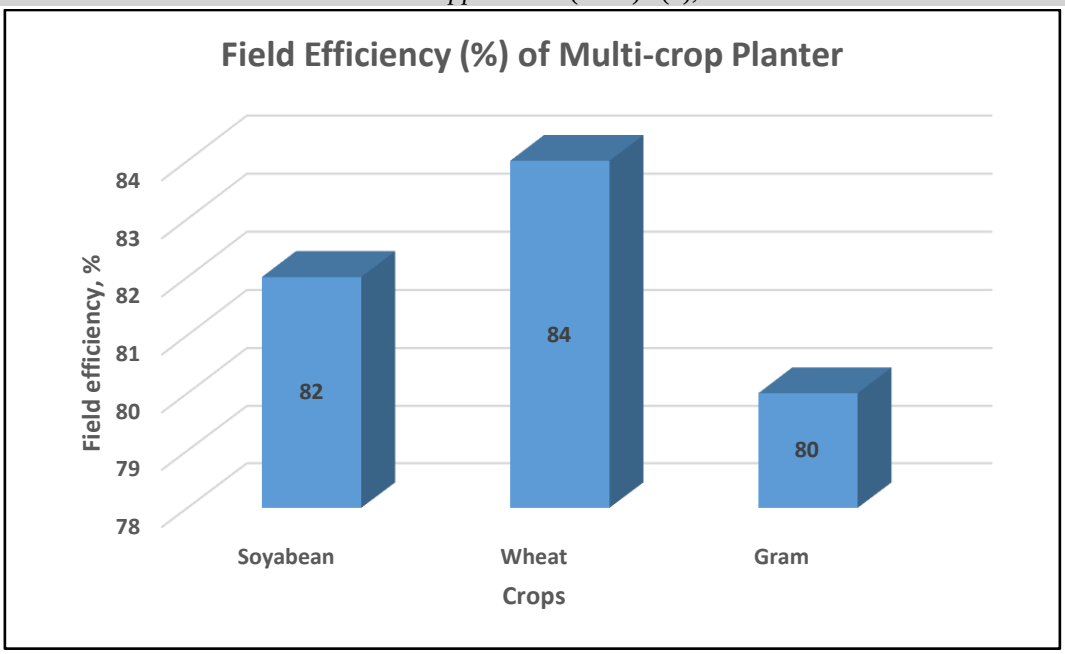

Fig. 3. Field efficiency of multi-crop planter

The average values of performance of the tractor drawn multi-crop planter are summarized and shown in Table 3. Average row to row spacing found was 20-30 cm. Average plant to plant spacing found was 5-20 cm and average depth of sowing found was 3 - 5 cm. The field capacity of planter found was 0.56 - 0.78 ha/ha and field efficiency found was 80- 85%.

Variation in seed dropping found was 5-6 , internal damage to seed was 0.45 - 0.85 % and missing hills found was 3-5% which are all within permissible range. Seed saving found was 15- 20%. Labour requirement for planting the crops was observed 4man-h/ha for all three crops.Average Fuel consumption found was 3.5-4.0 i/h and cost of operation found was Rs. 1340-1380/ha.

Table 3. Field performance data for evaluation of tractor drawn multi-crop planter for soybean, wheat and gram crops

Sr. No.	Performance Parameters	AverageValue
1	Area covered under FLD (ha)	10.20
2	Average row to row spacing (cm)	20-30
3	Average plant to plant spacing (cm)	5-20
4	Average Speed of operation (km/h)	3.4 - 3.8
5	Field capacity (ha/h)	0.56 - 0.78
6	Field efficiency (%)	80- 85
7	Variation in seed dropping (%)	5 – 6
8	Internal damage to seed (%)	0.45 - 0.85
9	Missing hills (%)	3-5
10	Average depth of sowing (cm)	3 – 5
11	Seed saving (%)	15- 20
12	Labour requirement (man-h/ha)	4
13	Average Fuel consumption (Lit/h)	3.5-4.0
13	Cost of operation (Rs/ha)	1340-1380

In the research trials, the total area covered was 10.20 ha at 09 different locations of Jabalpur district. Out of which was 5.40 ha were conducted at JNKVV fields and 4.80 ha were at farmer's field at 09 different locations. Table 4 shows the details of trial conducted on farmer's field and on JNKVV farm.

Table 4. Details of evaluation trials conducted of multi-crop planter

Sr. No	Name of farmer/ VV farm	Village/V.V	Crop	No. of trials conducted	Area covered (ha)
1	Farmers field	Keolari, Jabalpur	Soybean	02	1.10
2	Farmers field	Keolari, Jabalpur	Soybean, Gram	01	1.60
3	Farmers field	Lahod, Jabalpur	Wheat, Gram	01	0.90
4	Farmers field	Khiriya, Jabalpur	Gram, Soybean	01	1.20
5	University field	JNKVV, Jabalpur	Wheat, Soybean	02	2.40
6	University field	JNKVV, Jabalpur	Gram, Soybean	02	3.00
Total				**09**	**10.20**

Farmers feedback about machine has been taken during field trials. Farmers appreciated the overall precise performance of the machine and its suitability for different crop.The overall performance of tractor drawn multi-crop planter was found to be satisfactory.

Fig.4. View of soybean, wheat and gram crop sown by multi-crop planter at farmer's field

CONCLUSIONS

The overall functional performance of various systems of multi-crop planter was found satisfactory during laboratory and field trials. There was negligible damage of seeds and missing hills during operations. The field capacity was found to be between 0.55 - 0.79 ha/h and field efficiency was found to be 80-84% for various crops in different fields. The multi-crop planter maintained uniform row to row, plant to plant spacing and depth of seed placement. Hence from above research work it can be concluded that the multi-crop planter is suitable for sowing of seeds of almost all field crops like soybean, wheat, gram, moong, pigeon pea, crops with little adjustments in machinery.

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