Laboratory and Field Testing of Broad Bed Furrow Planter for Planting of Soybean Crop

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Abstract - The feasibility study of tractor operated broad bed furrow planter was carried out at Krishi Vigyan Kendra, Jalgaon Jamod. The planter was developed by department of Farm Power and Machinery, Dr. PDKV, Akola. The planter was tested in laboratory as per RNAM test code and field trials are carried out on farmer's field in Buldana District of Maharashtra under frontline demonstrations for soybean crop. The planter was used for preparing broad bed furrows and simultaneously sowing of seeds on beds. The laboratory test was conducted in which the average number of plants per metre was observed to 13.79 and plant population 459770 per hectare for soybean crop. The seed rate was calibrated and found to be 78.27 kg/ha for soybean crop. The visible damaged is very less in the planter and found to be 1.41% for soybean crop.The field test was conducted and field parameters were studied, the average field efficiency of the tractor and BBF planter was found to be 50.6 per cent for forward speed of 5.15 km/h. The rate of actual field coverage for BBF planter was observed 0.39 ha/h. The average width of broad bed and furrow was recorded as 1.50 m for soybean. The average row to row spacing was found to be 30 cm for soybean.

Keywords – BBF Planter, Field test, Laboratory test of machine, RNAM.

I. INTRODUCTION

Soybean occupies fourth place among oilseed crops in terms of acreage and production. Even though the commercial production of soybean began in early seventies with area of 15 thousand hectares, it had gone upto 1.63 million hectares of area with a production of 0.91 million tonnes in the year 2002-03.Karnataka, Andhra Pradesh and Maharashtra accounted for 45.05 percent, 30.77 percent and 16.48 percent production covering an area of 53.99 percent, 25.77 percent and 17.18 percent respectively during the year 2002-03 in the country. The production of soybean in Maharashtra and Madhya Pradesh during the year 2001-2002 is 1385.5 tonnes and 3735.0 tonnes respectively and during the year 2002-2003 is 1576.0 tonnes and 2576.1 tonnes respectively.

During 2001-2002, the total production touched to 5.27 million tonnes. The major Producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Andhra Pradesh and Karnataka.

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended row to row spacing seed rate, seed to seeds spacing and depth of seed placement vary from crop to crop and for different agro-climatic conditions to achieve optimum yields.

Under ridge- furrow system for closely spaced crops like wheat, gram, mustard etc, sowing (using seed drill) and removal of weeds were big problem. Hence Research activities were initiated in semi arid tropics (lCRISAT, 1984-1989; Krantz, 1981; Pathak *et al.*,1985; Karle, 1997) to develop broad bed and furrow system (BBF) (100-150 cm wide and 20 cm high beds and 45-50 cm wide furrows)so that sowing on the beds can be done with seed drill. Two, three or four rows of crop can be grown on broad bed and bed geometry can be varied to suit the cultivation and planting equipment. In India the system has been used mainly in deep vertisols (heavy black· cotton soils) where wide beds are formed by ox drawn wheel tool carriers. The tool carriers not only used for initial forming of beds but also for subsequent annual reshaping, planting and inter row cultivation.

In dry land agriculture simultaneous preparation of broad bed furrow and sowing operation with saving in production cost it is recommended to use tractor drawn PKV BBF planter. The role of the BBF was to make raised seedbeds and furrows more efficiently and effectively, thus reducing water logging and encouraging early planting of a cereal crop of an improved cereal variety which could then be followed by a second crop of pulses in the same growing season.

The broad bed furrow method encourages moisture storage in profile of soil. Safely disposing *off* surplus runoff without causing soil erosion. Providing a better drained and more easily cultivated soil in beds.

The technique worked best on deep black soils in areas with dependable rainfall averaging 750 mm or more. It has not been productive in areas of less dependable rainfall or on Alfisol or shallower Vertisols, although in later cases more productivity is achieved than with traditional farming methods (Ryan *et al.*,1979). The research revealed

(ICRISAT, 1989; Patra *et al.*, 1996; Ingole *et al., 1998)* that BBF system (on lands with slope less than 2%) in comparison to flat bed system induced good root development, good nodulation, better crop growth, better pod filling and early maturity in groundnut, besides considerable saving of time and cost of cultivation cost of cultivation.

Considering above discussion the BBF planter was tested in the laboratory and on farmer's field for field testing for the sowing of soybean crop. The BBF planter was tested as per the RNAM test codes and field performance test was carried out as per procedure of Mehta *et al.*, 2005. The present paper involved all the results obtained after testing of the implement and gives its feasibility for the field operation for the soybean crop.

II. METHODOLOGY

- LABORATORY TEST

The laboratory testing of broad bed furrow (BBF) planter was carried out at Krishi Vigyan Kendra, Jalgaon Jamod.

The planting pattern for the sowing of soybean crop is shown in figure.

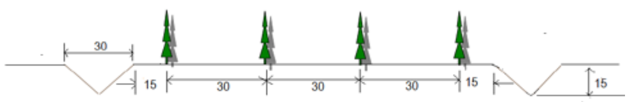

Fig. 2 BBF method of sowing for soybean

The standard procedure as per RNAM test codes 1995 was used to examine the BBF planter in the laboratory. Following procedure was adapted for the investigation.

Laboratory testing of tractor operated BBF planter

Laboratory testing of tractor operated Broad Bed Furrow planter was carried out in the workshop of College of Agricultural Engineering and Technology, Jalgaon Jamod in order to study following performance characteristics.

1) Number of seeds per metre and per hectare observed for soybean crop.
2) Calibration of seed planter for soybean crop.
3) Visible damage caused to the metered seed for soybean crop.

Number of seeds per metre and per hectare observed:

It is necessary to find out number of seeds which planter can plant per metre row length of field before its actual use in the field, to check whether it can achieve recommended (required) plant population. Also this determines the performance of metering mechanism of planter and plant spacing.

To determine number of plants per meter and per hectare, the following procedure was followed in laboratory.

(i) Seed hoppers were filled with 1 kg of colored seeds (for identification).

(ii) A sand bed of 3 x 2 m area and 10 cm deep was prepared on plane ground surface.

(iii) Then planter was operated on that prepared seed bed with normal speed to drop the seeds from furrow openers.

(iv) The seeds dropped on sand were identified by its color to measure seed to seed distance with steel tape.

(v) Average seed to seed spacing (P_s) in cm was calculated.

(vii) Average number of seeds per metre running length was calculated using formula.

$$n_p = \frac{100}{P_s}$$

Average number of seeds per hectare (plant population achieved) worked out as

$$\text{Plant population} = \frac{n_p}{RS} \times 10^6$$

Where,

RS – row to row spacing adopted in cm.

Total five replication were taken (of plant spacing) by repeating same procedure to calculate average number of plants per metre and per hectare observed.

Calibration of planter in laboratory:

Before taking the planter in to the field for actual use, it was calibrated to test the required seed rate per hectare of the crop to be sown. Following procedure was followed before actual calibration of planter.

Serial numbers were given to the furrow openers from left to right of the operator as 1, 2, 3 and 4, respectively.

The following steps were followed for calibration of the planter in laboratory.

1) Seed box was filled with seed.
2) The planter was jacked up in such a manner that it was exactly parallel to ground surface.
3) The reference point was marked on ground wheel with chalk piece.
4) The diameter of ground wheel was measured and noted as 'D' metre.
5) From diameter 'D', circumference of ground wheel was worked out i.e. πD.
6) Working width of planter was worked out as,

W= Width of broad bed + Width of single furrow+ Width of overlap furrow

Due to the ridger in BBF planter which will be overlap in every pass so the width of overlap is considered.

7) The planter was assumed to be used in a field of size 100 × 100 m^2.

8) The revolutions of ground wheel required to travel a distance of 100 m were calculated as,

$$X = \frac{100}{\pi \times D}$$

9) Polythene bags were attached to the each furrow opener to collect the metered seed.

10) 'X' revolutions were given to the ground wheel and seeds were collected from each furrow opener, separately.

11) Seeds collected from each furrow opener were weighed separately on digital weighing balance and total weight of seed was noted as 'P' kg.

12) Total number of revolutions required to cover one hectare area of the field were calculated as,

$$Y = \frac{100 \times 100}{\pi \times D \times W}$$

13) The total amount of seed for 'Y' revolutions and ultimately for 1 ha area was calculated as, for 'X' revolutions 'P' kg of seed was collected and for 'Y' revolutions it would be,

$$G = \frac{P}{X} \times Y, \text{kg}$$

Thus, 'G' was seed rate of that particular seed in kg/ha.

Readings were taken for different settings. Three replications for each setting were taken by repeating same procedure to calculate average seed rate for each setting.

Visible damage caused to the metered seed:

It was conducted to determine if any mechanical damage was done to the seed during calibration. Visible damage caused to metered seeds was represented by average crushing percentage of seeds. For that number of crushed seeds in every 100 seeds passed through each metering mechanism were counted and from observed data crushing percentage was calculated by using following formula.

$$\text{seed crushing (\%)} = \frac{\text{observed No. of seeds crushed}}{\text{No. of seeds passed through metering unit}} \times 100$$

Based on this methodology the reading had been taken and results were drawn.

III. FIELD TEST

Travelling Speed (km/hr):

For calculating traveling speed two poles 20 m apart was placed approximately in middle of the test run. On the opposite side also two poles were placed in similar position, 20m apart so that four poles forms corners of rectangle, parallel on long side of the plot. The speed was calculated from the time required for machine to travel the distance (20 m) between two poles. Average of such reading was taken to calculate the travelling speed of BBF Planter. The forward speed of operation was calculated by observing the distance traveled and time taken and calculated by following formula (Mehta *et al.*, 2005).

$$S = \frac{L}{t}$$

Where,

S = forward speed of machine, m/s

L = distance travelled, m

t = time taken, s

Theoretical Field Capacity: For calculating the theoretical filed capacity, working width and travelling speed were taken in to consideration. It is always greater than the actual field capacity.

Theoretical field capacity was calculated by using following formula (Mehta *et al.*, 2005).

$$T\,F\,C \;\square\square\; \frac{S\,W}{10}$$

Where,

T.F.C. = theoretical field capacity (ha/hr)

W = theoretical width of BBF planter (m)

S = speed of operation (km/h)

Effective Field Capacity: For calculating effective field capacity, the time consumed for actual work and lost forother activities such as turning and cleaning blade when clogged with weeds were taken in to consideration. Effective or actual field capacity was calculated by following formula (Mehta *et al.*, 2005).

$$\text{E.F.C.} = {}^{A}\!/_{Tp + T1}$$

Where,

E.F.C. = effective field capacity (ha/hr)

A = area (ha)

Tp = productive time (hr)

T1= non productive time, hr (Time loss for turning and cleaning blades)

Field Efficiency: Field efficiency was calculated by taking ratio of effective field capacity to theoretical field capacity. It is always expressed in percentage. It was calculated by following formula (Mehta et *al.*, 2005).

Field efficiency (%) $\frac{EFC}{TFC} \times 100$

Where,

E.F.C. = effective field capacity

T.F.C. = theoretical field capacity

Fuel Consumption: Fuel consumption was quantified by adopting standard procedure. The fuel tank was filled toits full capacity before and after the test. Amount of refueling after the test was measured which was the actual fuel consumption for test.

Fuel consumption was measured by recording time required and the quantity of fuel consumed for specified length of run and the fuel consumption was calculated on hourly basis as follows (Mehta *et al.*, 2005).

Plot1: Demonstration planting soybean crop with BBF planter (Method of planting)

Plot 2: In situ moisture conservation

Plot 3: Demonstration planting soybean crop with BBF planter (Tractor and BBF planter)

IV. RESULTS

The chapter result and discussion will reveal the finding in the testing of BBF planter in laboratory and in field test.

The BBF planter was tested for the plant to plant distance, plant population, seed rate and the seed damage observed in the metering device. The standard procedure explained in RNAM test code was used for the investigation.

Average number of plants per metre and per hectare observed in laboratory:

The BBF planter was tested in laboratory to determine seed spacing and number of plants per metre and per hectare of selected crops observed by the procedures.

Table 1 Number of soybean seeds (per metre and per ha) planted by BBF Planter in laboratory

Sr. No.	Furrow opener	Observed plant to plant distance					Plant to plant spacing (cm)P_s	Average number of plant per metre	Plant population per hectare
		R-I	R-II	R-III	R-IV	R-V			
1	FO1	7	6	8	6	6	6.6	15.15	505051
2	FO2	8	8	8	8	9	8.2	12.20	406504
3	FO3	7	7	7	8	7	7.2	13.89	462963
4	FO4	5	5	9	8	8	7	14.29	476190
5	Ave	6.75	6.5	8	7.5	7.5	7.25	13.79	459770

The plant to plant spacing for soybean crop was ranged from 6.6 cm and 8.2 cm and the average plant to plant spacing was 7.25 cm and average number of plant per metre 13.79 and the average number of plant population per hectare was 459770 as it is shown in Table 1.

Calibration of Broad Bed Furrow Planter for Selected Crops

The calibration of BBF planter for determination of seed rate per hectare was carried out for soybean crop. A standard procedure was adapted using metering plate having 23 Cells on its periphery were used for sowing of soybean crop.

Table 2: Calibration of BBF planter for soybean

Sr. No	Furrow opener	Weight of seed collected from each furrow opener for 106.15 revolutions					Treatment mean
		R-I	R-II	R-III	R-IV	R-V	
1	FO-I	0.26	0.33	0.32	0.3	0.31	0.30
2	FO-II	0.31	0.31	0.31	0.28	0.29	0.30
3	FO-III	0.29	0.28	0.3	0.29	0.3	0.29
4	FO-IV	0.3	0.25	0.27	0.3	0.27	0.28
Seed rate (kg/ha)		77.33	78.00	80.00	78.00	78.00	78.27

Visible Damage Cause to Metered Seed of Planter

The visible damage causes metered seed of soybean crop by passing 100 seeds through each metering unit and number of crushed seeds was counted, such three replications were taken. The data recorded during the test was presented.

Table 3: Visible seed damage cause to the metered seed of soybean

Sr. No.	Furrow opener	Damaged seed observed out of 100 seed			Average seed damage	Percentage of damage seed
		R-I	R-II	R-III		
1	FO1	2	1	2	1.66	1.66 %
2	FO2	2	1	2	1.66	1.66%
3	FO3	1	1	1	1	1%
4	FO4	1	1	2	1.33	1.33%
5	Average	1.5	1	1.75	1.41	1.41%

In visible seed damage caused to the metered seeds of soybean in BBF planter was carried out and seed damage percentage was calculated. The seed damage during for 106.15 revolutions of ground wheel it was observed that the seed damage was range from 1 to 2. The average seed damage was also calculated and it was ranges between 1to1.66 and with mean percentage 1.41

Travelling Speed

The forward travelling speed was calculated, as distance travelled 20 m and corresponding time was recorded as shown in table 4.

Table No. 4: Travelling speed of Tractor with BBF Planter in planting operation

Operation	Trial	Distance Travelled (m)	Time (s)	Speed (m/s)	Speed (km/h)
Sowing soybean crop with BBF Planter	1	20	28	1.39	5
	2	20	29	1.44	5.2
	3	20	31	1.56	5.6
	4	20	27	1.33	4.8
	Average	20	28.75	1.43	5.15

For 20 m forward distance travelled by tractor the average time recorded was 28.75 seconds as a result we will get average speed of 5.15 km/h

Theoretical field capacity

Theoretical field capacity depends upon travelling speed (km/h) of tractor and BBF planter and working width (m) of BBF planter in field conditions. Four trails on farmer's field were conducted and average trial readings were recorded in Table 5.

Table 5: Theoretical field capacity of Tractor with BBF Planter in planting operation

Operation	Trial	Speed (km/h)	Width of BBF Planter (m)	Theoretical Field capacity TFC, (ha/h)
Sowing soybean crop with BBF Planter	1	5	1.5	0.75
	2	5.2	1.5	0.78
	3	5.6	1.5	0.84
	4	4.8	1.5	0.72
	Average	5.15	1.5	0.77

It was found from table that, for average speed of 5.15 km/h and working width of BBF planter 1.5m we will get Field coverage TFC, 0.77 ha/h.

Effective field capacity

Effective field capacity (EFC) depends upon productive and unproductive i.e. time loss during planting operation of soybean crop with BBF planter. Four trails on farmer's field were conducted and average trial readings were recorded in Table 6.

Table 6: Effective field capacity of Tractor with BBF Planter in planting operation

Operation	Trial	Area (h)	Productive	Unproductiv	Total time	EFC,

			time Tp, (min)	e time T1 (min)	(h)	(ha/h)
Sowing soybean crop with BBF Planter	1	0.42	43	21	1.07	0.39
	2	0.45	41	16	0.95	0.47
	3	0.38	38	24	1.03	0.37
	4	0.37	42	23	1.08	0.34
	Average	0.40	41	21	1.03	0.39

It was found from table that, for average area of 0.405ha and average productive time was 41 min that of unproductive time was found to be 21 minutes. The average effective field capacity, EFC was recorded as 0.39 ha/ha.

Field Efficiency

Field efficiency is the ration of effective field capacity to theoretical field capacity. Four trails on farmer's field were conducted and average trial readings were recorded in Table 7.

Table 7: Field Efficiency of Tractor with BBF Planter in planting operation

Operation	Trial	EFC, (ha/h)	TFC, (ha/h)	Field efficiency (%)
Sowing soybean crop with BBF Planter	1	0.39	0.75	52.0
	2	0.47	0.78	60.3
	3	0.37	0.84	44.0
	4	0.34	0.72	47.2
	Average	0.39	0.77	50.6

It was found from table that, for BBF planting operation for soybean crop average Theoretical field capacity was found 0.77 ha/h, average effective field capacity was found to be 0.39 ha/h and average field efficiency was recorded 50.6 per cent.

V. CONCLUSION

If the sowing operation in the agriculture cycle carry out precisely then the probability of good production from the paddock increases. So it is need to carry out sowing operation with a precise and modern tool like Broad Bed Furrow Planter. The laboratory performance of BBF planter was evaluated in the laboratory and in the field as per RNAM test codes. Laboratory tests were conducted at KVK, Jalgaon Jamod and field trials were through frontline demonstrations were conducted on farmers field.. The performance of BBF planter was evaluated by determining seed to seed distance, seed rate, visible seed damage in laboratory test and speed, field efficiency and field coverage in field test was evaluated.

After conducting the laboratory test and field test of BBF planter in accordance with standard test procedure, results were calculated and from these readings final conclusions were drawn which are as follows.

- After evaluating the performance of BBF planter, it can be concluded that BBF planter was suitable for the selected soybean crop.
- The laboratory test of the planter for plant to plant distance, plant population, seed rate per hectare and visible damage was satisfactory and it could be used for the field trials.
- The field performance test results shows that field efficiency of the BBF planter was found very low resulting in low field coverage.

VI. FUTURE SCOPES

The application of field and laboratory test will be helpful for deciding the practical utility of farm machineries. New farm machines should be tested in laboratory and in field conditions before spread for practical utilities.

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