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Laboratory testing of broad bed furrow planter for different crops

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ABSTRACT : The feasibility study of tractor operated broad bed furrow planter was carried out at College of Agricultural Engineering and Technology, Jalgaon Jamod with assistance of Krishi Vigyan Kendra, Jalgaon Jamod during 2012-2013. 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 for the crops sunflower, soybean and chickpea, respectively. 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 be 5.38, 13.79 and 13.33 and plant population 122775, 459770 and 444444 per hectare for sunflower, soybean and chickpea, respectively. The seed rate was calibrated and found to be 7.7 kg/ha, 78.27 kg/ha and 77.20 kg/ha for sunflower, soybean and chickpea, respectively. The visible damaged is very less in the planter and found to be 1.5% for sunflower, 1.41% for soybean and 1.58% for chickpea. The average width of broad bed and furrow was recorded as 1.95 m, 1.50 m and 1.50 m for sunflower, soybean and chickpea, respectively. The average row to row spacing was found to be 45 cm, 30 cm and 30 cm for sunflower, soybean and chickpea, respectively.

KEY WORDS : Broad bed furrow planter, Laboratory testing, Calibration

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Farm mechanization is the application of engineering technology in agricultural operations to do a job in a better way to improve productivity. This includes development, application and management of all mechanical aids for field production, water control, material handling, storing and processing. Sustainable development in agriculture can be achieved by use of mechanization in agriculture. Mechanization can help in increasing the overall production by timely farm operation, reducing losses, reducing the cost of operations. Introduction of high yielding varieties of crop, introduction of high dose of fertilizers and pesticides for different crops. Introduction of new crops in different parts of the country, multi cropping system and intensive cultivation, followed in different parts of the country and also farm mechanization helps to reduce the loss of produce and drudgery of farmers thus improving comforts of farmers.

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as "Surajmukhi." The name "Helianthus" is derived from 'Helios' meaning 'Sun' and 'anthos' meaning 'flower'. It is one of the fastest growing oilseed crops in India. In early 1970s, only about 0.1 million hectares were under oilseed crops in India. In early 1970s, only about 0.1 million sunflower cultivation, however by 2002- 03, it had gone upto 1.63 million hectares. In India, it was used mainly as ornamental crop but in recent past it became an important source of edible and nutritious oil.

Soybean occupies fourth place among oilseed crops in terms of acreage and production. Even though the commercial production of sunflower 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 per cent, 30.77 per cent and 16.48 per cent production covering an area of 53.99 per cent, 25.77 per cent and 17.18 per cent, 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.

Bengal gram is called chickpea or gram (*Cicer aritinum* L.) in South Asia and Garbanzo bean in most of the developed world. Bengal gram is a major pulse crop in India, widely grown for centuries and accounts for nearly 40 % of the total pulse production. India is the major growing country of the world, accounting for 61.65 per cent of the total world area under Bengal gram during 2002 and 68.13 per cent of the total world production.

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 was 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 for the above sunflower, soybean and chickpea crops. The BBF planter was tested as per the RNAM test codes. The present paper involved all the results obtained after the laboratory testing of the implement and gives its feasibility for the field operation for the said crops.

METHODOLOGY

The laboratory testing of broad bed furrow (BBF) planter was carried out in College of Agricultural Engineering and Technology Jalgaon Jamod. The department of farm power and machinery Dr. PDKV, Akola developed broad bed furrow planter was used for investigation with assistance of Krishi Vigyan Kendra, Jalgaon Jamod.

Following crops were selected for experiment namely

1) Sunflower 2) Soybean 3) Chick pea

The planting pattern for the sowing of respective crops *i.e.* sunflower, soybean and chickpea in shown in Fig. A, B and C, respectively.

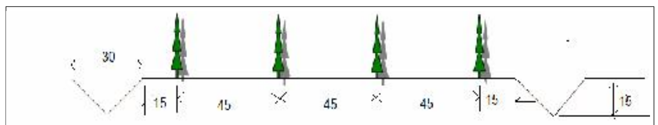

Fig. A : BBF method of sowing for sunflower

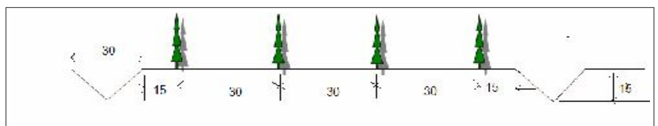

Fig. B : BBF method of sowing for soybean

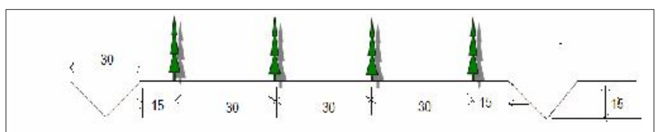

Fig. C : BBF method of sowing for chickpea

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.

– Number of seeds per metre and per hectare observed for sunflower, soybean and chickpea crop.

– Calibration of seed planter for sunflower, soybean and chickpea crop.

– Visible damage caused to the metered seed for sunflower, soybean and chickpea 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 metre and per hectare, the following procedure was followed in laboratory.

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

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

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

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

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

– 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. Sunflower, soybean and chickpea seed was used for calibration, respectively.

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

– Seed box was filled with seed.

– The planter was jacked up in such a manner that it was exactly parallel to ground surface.

– The reference point was marked on ground wheel with chalk piece.

– The diameter of ground wheel was measured and noted as 'D' metre.

– From diameter 'D', circumference of ground wheel was worked out *i.e.* πD.

– 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.

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

– The revolutions of ground wheel required to travel a distance of 100 m were calculated as

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

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

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

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

– Total number of revolutions required to cover one hectare area of the field were calculated as

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

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.

RESULTS AND DISCUSSION

The laboratory testing of the broad bed furrow planter was carried out in the College of Agricultural Engineering and Technology, Jalgaon Jamod for various crops namely sunflower, soybean and chickpea.

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

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.

The plant to plant spacing for sunflower crop was ranged from 16.2 cm and 19.4 cm and the average plant to plant spacing was 18.1 cm and average number of plant per metre 5.52 and the average number of plant population per hectare was 122775 as it is shown in Table 1.

The plant to plant spacing for sunflower 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 2.

Table 1 : Number of sunflower 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	18	17	21	21	16	18.6	5.38	119474
2.	FO2	15	15	17	14	20	16.2	6.17	137174
3.	FO3	18	17	21	18	23	19.4	5.15	114548
4.	FO4	17	22	16	19	17	18.2	5.49	122100
5.	Ave	17	17.75	18.75	18	19	18.1	5.52	122775

Table 2 : 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

Table 3: Number of chickpea 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	8	9	10	7	7	8.2	12.20	406504
2.	FO2	7	9	9	7	8	8	12.50	416667
3.	FO3	9	8	8	6	6	7.4	13.51	450450
4.	FO4	6	7	6	7	6	6.4	15.63	520833
5.	Ave	7.5	8.25	8.25	6.75	6.75	7.5	13.33	444444

Table 4 : Calibration of BBF planter for sunflower

Sr. No.	Furrow opener	Weight of seed collected from each furrow opener for 106.15 revolutions					Treatments mean
		R-I	R-II	R-III	R-IV	R-V	
1.	FO-I	0.043	0.044	0.041	0.038	0.036	0.04
2.	FO-II	0.036	0.038	0.031	0.036	0.036	0.04
3.	FO-III	0.036	0.037	0.03	0.036	0.037	0.04
4.	FO-IV	0.041	0.04	0.036	0.038	0.036	0.04
	Seed rate (kg/ha)	8.0	8.2	7.1	7.6	7.4	7.7

The plant to plant spacing for sunflower crop was ranged from 6.4 cm and 8.2 cm and the average plant to plant spacing was 7.5 cm and average number of plant per metre 13.33 and the average number of plant population per hectare was 444444 as it is shown in Table 3.

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 selected crops namely sunflower, soybean and chickpea. A standard procedure was adapted using metering plate having 6, 23 and

Table 5 : 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

Table 6 : Calibration of BBF planter for chickpea

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	0.3	0.29	0.31	0.32	0.27	0.30
2.	FO-II	0.31	0.3	0.27	0.29	0.3	0.29
3.	FO-III	0.29	0.28	0.24	0.27	0.28	0.27
4.	FO-IV	0.3	0.27	0.31	0.3	0.29	0.29
	Seed rate(kg/ha)	80	76	75.33	78.67	76	77.20

Table 7 : Visible seed damage cause to the metered seed of sunflower

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	1	2	2	1.66	1.66 %
2.	FO2	2	1	2	1.66	1.66%
3.	FO3	1	1	1	1	1%
4.	FO4	2	1	2	1.66	1.66%
5.	Average	1.5	1.25	1.75	1.5	1.5%

Table 8 : 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%

Table 9 : Visible seed damage cause to the metered seed of chickpea

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	1	1	2	1.33	1.33%
2.	FO2	2	1	2	1.66	1.66%
3.	FO3	2	1	1	1.33	1.33%
4.	FO4	2	2	2	2	2%
5.	Average	1.75	1.25	1.75	1.58	1.58%

23 cells on its periphery were used for sunflower, soybean and chickpea, respectively.

In calibration of BBF planter for sunflower was carried out and seed rate was calculated. The seed collected during the calibration for 106.15 revolutions of ground wheel it was observed that the seed collected was ranged from 0.03 kg to 0.043 kg. The seed rate was also calculated and it ranged between 7.1 kg to 8.2 kg and with mean 7.7 kg for sunflower which is in the permissible for the recommended seed rate of the sunflower (Table 4).

In calibration of BBF planter for soybean was carried out and seed rate was calculated (Table 5). The seed collected during the calibration for 106.15 revolutions of ground wheel it was observed that the seed collected ranged from 0.25 kg to 0.33 kg. The seed rate was also calculated and it ranged between 77.33 kg to 80 kg and with mean 78.27 kg for soybean which is in the permissible for the recommended seed rate of the soybean.

In calibration of BBF planter for chickpea was carried out and seed was calculated. The seed collected during the calibration for 106.15 revolutions of ground wheel it observed that (Table 6) the seed collected ranged from 0.24 kg to 0.32 kg. The seed rate was also calculated and it was ranged between 75.33 kg to 80 kg and with mean 77.20 kg for chickpea which is in the permissible for the recommended seed rate of the chickpea.

Visible damage cause to metered seed of planter :

The visible damage causes metered seed of sunflower, soybean and chickpea by passing 100 seeds through each metering unit and number of crushed seeds was counted, such three replication were taken. The data recorded during the test presented (Table 7, 8 and 9).

In visible seed damage caused to the metered seeds of sunflower 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 1 to 1.66 and with mean percentage 1.5 (Table 7).

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 ranged between 1 to 1.66 and with mean percentage 1.41% (Table 8).

In visible seed damage caused to the metered seeds of chickpea 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 ranged between 1.33 to 2 and with mean percentage 1.58 % (Table 9).

The laboratory testing of BBF planter was evaluated and performance of the planter was found to be satisfactory.

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 as per RNAM test codes. Laboratory tests were conducted in the CAET, Jalgaon Jamod. The performance of BBF planter was evaluated by determining seed to seed distance, seed rate and visible seed damage

After evaluating the performance of BBF planter, it can be concluded that BBF planter was suitable for the selected crops namely sunflower, soybean and chickpea. The performance 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.

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