

Development and evaluation of bullock drawn engine operated high clearance sprayer for pigeonpea crop

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■ **ABSTRACT** : The pest and disease infection is a serious problem in pigeonpea crop during the plant growth. At present, the farmers are generally using the available manually operated knapsack and motorized sprayers. A bullock drawn engine operated high clearance sprayer was developed at the College of Agricultural Engineering, Raichur, by taking the above factors into consideration and the field trials were carried out. The experiment was conducted at research farm for spraying on pigeonpea crop using bullock drawn engine operated sprayer. This sprayer has been tested using a pair of bullock (Breed: Khillari) under physiological limits of bullocks with visual fatigue symptoms. The average field capacity of bullock drawn engine operated sprayer for spraying on pigeonpea crop was found to be 1.18 ha/h. The average draft observed was 736 N. The cost of operation worked out for spraying operation for bullock drawn engine operated sprayer for spraying on pigeonpea crop was Rs. 114.90 per ha. The physiological response of bullocks and fatigue score for spraying operation was within the limit. The bullock drawn engine operated sprayer requires the labour requirement of 12.85 man-h/ha.

■ **KEY WORDS** : Pigeonpea, Bullock drawn sprayer, High clearance, Pest attack

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Pigeonpea/Red gram is a predominant crop grown by the farmers in Raichur region of Karnataka. The red gram crop is highly susceptible to insect attack. The pest and disease infection is a serious problem during the plant growth. At present, the farmers are generally using the available manually operated knapsack and motorized sprayers. The farmers generally spray 5-6 times on red gram crop over the entire period. The uniformity of spraying is not achieved by manually operated sprayers. The uniformity in spraying is essential to cover large crop canopy in the plants. The effective application of pesticide for pest control using spraying equipment play an important role. The chemical solution to be sprayed on crop as per the dosage requirement is essential to control the pest and diseases. The height of crop and its density increases with the stage of growth of the crop and the effectiveness of manually operated spraying decreases. The farmers are also facing acute labour shortage and there is a demand of higher labour wages. Use of tractor operated sprayer in red gram crop is not very popular and also not feasible due to low ground clearance which may damage the crops.

A bullock drawn engine operated high clearance sprayer was developed at the College of Agricultural Engineering, Raichur, by taking the above factors into consideration and the field trials were carried out. The introduction of bullock drawn engine operated sprayer for red gram crop reduce the dependency on labours during spraying operation and large area can be covered within short period of time. The development of such sprayer is expected to make mechanization of spraying more efficient and cost effective and help in timely completion of a critical operation like spraying of plant protection chemicals. Hence, this study is aimed to help the farming community of this region as well as popularization elsewhere in the country.

■ METHODOLOGY

A bullock drawn engine operated high clearance sprayer was developed and the performance evaluation was carried out for red gram crop. The sprayer was evaluated using a pair of bullock (breed: Khillari) under physiological limits of bullocks with visual fatigue symptoms.

Bullock drawn engine operated sprayer:

A commercially available bullock drawn sprayer and 3 hp Honda power sprayer were procured. For installing the 3 hp petrol-cum-kerosene engine in the bullock drawn sprayer, a suitable size platform of length 583 mm and width 308 mm was fabricated and fitted in front portion of cart and 3 hp Honda power sprayer was mounted. A pair of bullock was used for pulling the cart and the engine was used as power source for carrying out spraying operation. The developed bullock drawn engine operated sprayer was used for spraying on red gram crop in the research farm as well as in the farmers fields.

In the bullock drawn engine operated high clearance sprayer, the bullock power was used for providing tractive power for pulling the cart and the engine power for creating

the pressure required for spraying. The specifications of bullock drawn engine operated sprayer are presented in Table A.

Field performance of bullock drawn engine operated sprayer on pigeonpea crop:

The experiments on spraying for red gram crop were conducted with three replications and three treatments during *Kharif* season. The preliminary data pertaining to crop such as rows spacing, plant to plant distance, height of crop etc., were measured. For spraying operation, the recommended chemical solution as per the plant requirement was prepared separately in a tank. The chemical solution was thoroughly mixed and the same solution was poured in to the chemical tank of spraying machine and also filtered it. The wheel adjustments were carried out in accordance with row spacing of the crop. The field performance of sprayer was carried out in an area of one hectare of pigeonpea crop. During the trials, the data on speed of operation, swath width, draft, fuel consumption, discharge rate and power output were measured. The physiological response of bullocks and behavioral symptoms were observed during work-rest schedule before and after spraying operation. The cost of operation for this sprayer has been worked out.

Physiological response of bullocks for spraying operation on pigeonpea crop:

The bullock drawn engine operated sprayer was tested for spraying on pigeonpea crop using a pair of bullock (Breed: Khillari). The experiments have been carried out for four working hours under the work-rest schedule 1 hr work - ½ hr rest-1 hr work - ½ hr rest-1 hr work - ½ hr rest-1 hr work. The physiological response of bullocks namely pulse rate, respiration rate and body temperature were measured before and after spraying operation. The pulse rate (PR) of bullocks (Karna and Arjun) was measured by using stethoscope. The respiration rate (RR) was recorded by counting the number of blows per minute at the nostril. The body temperature was recorded by using clinical thermometer. The physical behavioral symptoms of bullocks such as frothing, inhibition of progressive movement, leg un-coordination, excitement and tongue protrusion were observed just before the end of spraying operation for each test. The fatigue scores were determined as per the fatigue score card developed by Upadhya (1987). The meteorological parameters such as ambient temperature, relative humidity, wind velocity and sunshine condition were recorded during trials for both crops. The data collected during field trials were analyzed and fatigue scores were developed for a pair of bullocks.

■ RESULTS AND DISCUSSION

The experiments on spraying for red gram crop have

Sr. No.	Particulars	Details
1.	Overall dimensions	
	length (mm)	3,900
	width (mm)	1,240
	height (mm)	2,120
	weight (kg)	305
2.	Power source for spraying	3 hp engine
3.	Power source for pulling of cart	A pair of bullock
4.	Engine specifications	
	Rated power	2.28 kW / 3600 rpm
	Fuel used	Kerosene, Petrol
	Crank case oil	SAE 10W40/DAE 20W40
	Specific fuel consumption (g/kW-h)	600
	Model	GK 200 Honda
5.	Pump specification a) RPM	500-800
	b) Suction, l/min	17-27
	c) Pressure, kg/cm ²	20-35
	d) HP	1.5-3
6.	No. of nozzles	7
7.	Diameter of wheel (mm)	1,230
8.	Ground clearance (mm)	920
9.	Width of wheel (mm)	70
10.	Adjustable boom height range (mm)	400 to 1650
11.	Boom length (mm)	5200
12.	Wheel tread (mm)	1200
13.	Walking speed of bullock (kmph)	2-3.5
14.	Tank capacity, litre	200
15.	Pump	HTP
16.	Type of nozzle	Hollow cone
17.	Pressure range (kg/cm ²)	0-70
18.	Cost of equipment, Rs.	53,000

been carried out with bullock drawn engine operated sprayer with three replications in research farm. The field trials were carried out under work-rest schedule to assess the physiological response of bullocks for developing fatigue scores within limits. The biometric parameters of red gram crop in the field were measured and are presented in the Table 1.

The pigeonpea crop (variety: TS-3R) planted at row spacing of 900 mm with plant to plant distance in a row of 600 mm was selected for the trials. The average height of crop was 1587 mm at crop standing period of 105 days. The pigeonpea crop was infested with pest at tender leaves and plant also attained the flowering stage.

Field performance of bullock drawn engine operated sprayer for pigeonpea crop :

During the field trials, the wheel tread of bullock drawn sprayer was adjusted to suit the row spacing. The minor adjustments at yoke and engine side were made before starting the trials. The recommended chemical solution was prepared

separately and stored in the tank. The chemical solution was poured into the chemical tank (500 l capacity) by filtering it through filter to avoid any foreign materials which may block the spray nozzles. The entire crop canopy area was measured and the spraying operation was carried out. The working of bullock drawn engine operated sprayer for pigeonpea crop in the research farm is shown in Plate 1 and its demonstration carried out in the farmers field is shown in Plate 2. The field performance results of bullock drawn engine operated sprayer for pigeonpea crop carried out in the research farm is presented in the Table 2.

From the Table 2, it is revealed that the sprayer was capable to cover six rows at a time using a spray boom in which seven spray nozzles were fixed. The boom height was adjusted in accordance with the height of pigeonpea crop. The sprayer was operating at a pressure of 20 kg/cm² giving an average discharge of 708 l/h at the forward speed of 2.71 km/h. The operating pressure was maintained at constant level by locking the throttle lever. The sprayer exerted a draft of 736.0 N during spraying operation. The average field capacity

Table 1 : Biometric parameters of pigeonpea crop

Sr. No.	Parameters	Value			Average
		R ₁	R ₂	R ₃	
1.	Variety	TS-3R			
2.	Height of crop, mm	1550	1580	1630	1587
3.	Crop standing period, days	105	105	105	105
4.	Spacing of crop : - row to row, mm	920	915	917	917
	- plant to plant, mm	615	610	616	614
5.	Research plot, ha	1	1	1	1
6.	Number of branches	52	55	58	55

Table 2 : Field performance of bullock drawn engine operated sprayer for pigeonpea crop in the research farm

Sr. No.	Parameters	Value			Average
		R ₁	R ₂	R ₃	
1.	Variety	TS-3R			
2.	Row spacing, mm	920	915	917	917
3.	Plant to plant, mm	615	610	616	614
4.	No. of rows covered,	6	6	6	6
5.	Swath width, mm	4500	4575	4570	4548
6.	Boom length, mm	5200	5200	5200	5200
7.	Operating pressure, kg/cm ²	20	20	20	20
8.	Discharge rate, l/h	698	715	710	708
9.	Speed of travel, kmph	2.68	2.82	2.72	2.71
10.	Draft, N	784.80	686.7	735.75	736.0
11.	Field capacity, ha/h	1.17	1.19	1.20	1.18
12.	Power output, kW	0.60	0.55	0.57	0.57
13.	Quantity of chemical solution per ha, l/ha	596.6	600.8	591.7	596.4
14.	Fuel used	Kerosene, Petrol : start			
15.	Fuel consumption ml/kW-h	720	665	640	675.0
	Ltr/ha	1.33	1.34	1.15	1.27



Plate 1 : A view of bullock drawn engine operated sprayer for pigeonpea crop in the research farm



Plate 2 : Working of bullock drawn engine operated sprayer for pigeonpea crop in the farmers field

of sprayer was found to be 1.18 ha/h with the power output of 0.57 kW. In the engine, kerosene was used as a fuel for running the engine and the fuel consumption was found to be 1.27 l/ha. The total quantity of chemical solution sprayed during the experiment was 596.4 l/ha. The bullock drawn engine operated sprayer worked satisfactorily during the field trials.

Physiological response of bullocks and fatigue score for bullock drawn engine operated sprayer for pigeonpea crop:

During spraying operation on pigeonpea crop, the fatigue

score card for bullocks developed by Upadhyay (1987) has been used to assess the physiological response of animals such as respiration rate (RR), pulse rate (PR) and body temperature (BT). The physical behavioral symptom of animals was also observed to develop fatigue score. These data together with the performance of sprayer in the field will give the relation between work load on bullocks and spraying operation. The data pertaining to physiological response of bullocks and fatigue score for bullock drawn engine operated sprayer is presented in Table 3.

From the Table 3 it is observed that the fatigue score of

Table 3 : Physiological response of bullocks and fatigue score for spraying in pigeonpea crop using bullock drawn engine operated sprayer

Sr. No.	Parameters	Working hours							
		LB	RB	LB	RB	LB	RB	LB	RB
1.	Physiological parameters of bullocks – Before work								
	Respiration rate (RR), (Breaths/min)	28	23	29	25	30	24	32	26
	Pulse rate (PR) (Beats/min)	36	34	36	33	42	36	40	36
	Body temperature (BT)°C	37.2	37.2	37.4	37.4	37.3	37.3	37.4	37.3
2.	Physiological parameters of bullocks – After work								
	Respiration Rate (RR), (Breaths/min)	38(0)	33(0)	46(1)	44(1)	61(2)	55(2)	70(2)	66(2)
	Pulse rate (PR) (Beats/min)	44(0)	40(0)	46(1)	44(1)	52(1)	46(1)	62(2)	57(2)
	Body temperature (BT)°C	37.7 (1)	37.7 (1)	37.9 (1)	37.9 (1)	38.3 (2)	38.4 (2)	38.5 (2)	38.4 (2)
3.	Physical behavioral symptoms								
	Frothing	(1)	(1)	(2)	(1)	(2)	(2)	(2)	(2)
	Inhibition of progressive movement	(1)	(0)	(2)	(1)	(2)	(2)	(2)	(3)
	Leg un-cordination	(1)	(0)	(1)	(1)	(1)	(1)	(2)	(2)
	Excitement	(0)	(1)	(0)	(0)	(1)	(1)	(2)	(2)
	Tongue protrusion	(0)	(0)	(0)	(0)	(1)	(0)	(2)	(2)
4.	Total fatigue score	(4)	(3)	(8)	(6)	(12)	(11)	(16)	(17)

Breed of bullocks : Khillari Ambient temperature : 30°C
 Operating pressure : 20 kg/cm² Relative humidity : 63%
 Draft : 736 N Sunshine condition : Bright and car
 Work-rest-schedule : 1 hr W - ½ hr R - 1 hr W - ½ hr R - 1 hr W - ½ hr R - 1 hr W
 (4 working hours)

Note: LB = Left Bullock, RB = Right Bullock

Table 4 : Cost of operation and labour requirement for spraying on pigeonpea crop in research farm

Sr. No.	Particulars	Bullock drawn engine operated sprayer
1.	Cost of machine including cart, Rs.	53,000
2.	Power source	Kerosene Petrol: Start Bullock power for traction purpose
3.	No. of labourers required including operator	2
4.	Cost of operation – Rs/h	135.62
	- Rs/ha	114.90
5.	Per cent of financial saving over the local method	37.67
6.	Labour requirement man-h/ha	12.85
7.	Percent of labour saving over the local	71.28

4 and 3 have been found during first hour of operation and subsequently the fatigue score increased to 16 and 17 at the end of fourth hour of spraying operation. The physiological response of bullocks was found to be within the limits.

Cost of operation and labour requirement for spraying on pigeonpea crop:

The cost of operation and labour requirement for spraying on pigeonpea crop has been worked out and presented in Table 4.

The data revealed that, the cost of operation per hour for bullock drawn engine operated sprayer was Rs. 135.62 per hour. The financial saving of 37.67 per cent was observed over local method. The bullock drawn engine operated sprayer worked satisfactorily as the discharge rate can be maintained easily and with lesser cost of operation (Rs. 114.90/ha). The labour requirement in man-hr per hectare was 12.85 for bullock drawn engine operated sprayer. The labour saving of 71.28 per cent was observed over the local method.

Conclusion :

The experiment was conducted at research farm for spraying on pigeonpea crop using bullock drawn engine operated sprayer. This sprayer has been tested using a pair of bullock (Breed: Khillari) under physiological limits of bullocks with visual fatigue symptoms.

The average field capacity of bullock drawn engine

operated sprayer for spraying on pigeonpea crop was found to be 1.18 ha/h. The average draft observed was 736 N. The cost of operation worked out for spraying operation for bullock drawn engine operated sprayer for spraying on pigeonpea crop was Rs. 114.90 per ha. The physiological response of bullocks and fatigue score for spraying operation was within the limit. The bullock drawn engine operated sprayer requires the labour requirement of 12.85 man-h/ha.

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