Int.J.Curr.Microbiol.App.Sci (2017) *6*(10): 2749-2763

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 10 (2017) pp. 2749-2763**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.610.323

Modification and Performance Evaluation of Animal Drawn Onion Seeder

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Keywords

Allium cepa L., Onion seeder, Drums, Peg system, Onion cultivation.

Article Info

Accepted:
23 September 2017
Available Online:
10 October 2017

A B S T R A C T

Onion (*Allium cepa L*) is the most economical vegetable often used as a spice. The farming of onion on rainfed areas, by using broad casting method is very difficult. Broadcasting method results in the higher amount of seed rate, non-uniform distribution of seeds, poor bulb maturity, higher nutrient competition, and more over it is a time consuming and laborious process. By taking all these factors into consideration an animal drawn onion seeder was developed under rainfed onion crop cultivation with a reasonable cost of operation. The field area was divided into 6 no. of plots with length 20 m and width of 1.6 m. Number of germinated seedlings in a square meter, plant to plant spacing and row to row spacing were replicated 5 times in each plot with ⅓rd, ½, ⅔rd volume of filling in drums. The number of seedlings/ sq. m, in ⅓rd volume of drum filling with double row holes (29) were more and found to be 150 number, and single row holes (14) was less and found to be 52 number, In plant to plant spacing, ½ drum filling single row holes (14) gave more spacing which was about 10.57 cm and ⅓rd drum filling double row holes (29) gave less spacing which was about 5.358 cm. In row to row spacing, with ½ filling single row holes (14) gave more spacing which was found to be 11.55 cm and with ⅓rd filling double row holes (29) gave less spacing 6.073 cm. The seeder with single row holes open with ⅔ rd of drum filling was selected to drop the onion seed in the rainfed area. The recommended onion seedlings should be in the range of 75 to 80 per sq. m with a row to row spacing of 7.5 to 8 cm and plant spacing of 6 to 8 cm. The above recommendations were met with single row holes (14) opened with ⅔ rd of drum filling. Field capacity of the seeder with single row holes (14) open and ⅔ rd of drum filling were 0.32 ha/hr. Row to row spacing was 7.9 cm with germination percentage of 97.3. The cost of the developed animal drawn onion seeder was Rs. 16,100.

Introduction

Onion (*Allium cepa L.)* is one of the important commercially cultivated vegetable crops grown throughout India. It is widely grown in different parts of the country mainly by all category of farmers and also consumed worldwide.

India produces about 13 per cent of total worlds production and ranked second after China. Onion is grown in an area of 1.0 million hectare in India with the production of 15.1 million tonnes over a productivity of 14.2 tonnes/hectare. The important onion growing states are Maharashtra, Bihar, Karnataka, Gujarat, Andhra Pradesh, Orissa and Madhya Pradesh. The total area under onion cultivation in Karnataka is about 1.90 lakh hectares with a production of 2.5 million

tonnes and productivity of 13.6 tonnes/hectare (Vijay Kumar, 2011).

Onion is an important and indispensable item in every Indian kitchen. As a culinary ingredient it adds to the taste and flavour in a wide range of food preparations. Onion bulbs can be sautéed, grilled, boiled, baked and fried or stuffed. It is used as salad or cooked in various ways in all curries. It is also used in processed forms e.g. flakes, powder paste, pickles etc. It has very good medicinal value and nutritive value. Onion is processed in the form of dehydrated products like flakes, powder, pickles paste, canned and bottled. Processed products of onion are in good demand in local market for defense and fast food industries and also exported to exotic markets to earn valuable foreign exchange (Ramya, 2006).

Thus, there is a steady demand for onions not only in India, but also throughout the world. Onion production might be increased by increasing the area with good variety or by changing the existing management practices. Through improved seed production, both yield and quality can be improved, to fetch higher prices in the market. Therefore, there is a need to increase the supply of quality seed to increase the productivity.

The vegetable cultivation is usually adopted by small and marginal farmers under intensive cropping system. The area under onion cultivation is about 36,842 ha with annual production of about 8,49,000 mt (BBS, 2007). The national average yield of onion is very low as 6.94 tonne ha-1 while the world average yield is about 20.64 tonne ha-1 (FAO, 2006). To meet up the demand of increased population, onion production should be increased with lower production cost. Macias *et al.,* (2004) observed that the system of direct seeding obtained better yield (18%), bulb weight (21%) and precocity (11 days) in comparison to the transplant methods. In case of rain fed condition, the onion seeds are broadcasted to save the labour and the yield of around 4.5 tonnes ha-1 was obtained. The poor yield was recorded due to non-uniform spacing of seeds which affected the size of the onion bulbs.

Seed is the basic and crucial input in agricultural production. But the seed quality plays an important role, as the crop yield is directly dependent on seedling emergence and establishment. The quality of seed either for seed production or for general cultivation depends on several factors that influence the planting value of the seeds. Of these, parameters like time of `harvest, threshing methods and seed moisture have considerable effect on seed quality especially in vegetable crops like onion (Steiner and Akintobi, 1986).

By broadcasting, the seed rate is more, bulb maturity is not good, non-uniformity of spacing and time consumption is more. By considering all these problems, Animal drawn onion seeder was fabricated and onion seeds are broadcasted under rainfed condition.

Broadcasting method reduces the yield & produce due to non-uniform placement of seeds. Here seed drill is to be preferred for recommended rate of seed and row spacing which helps in intercultural practice. Since the onion seed is of less diameter, more seeds will be dropped in a furrow otherwise pneumatic system has to be developed to convey one/two seed from metering unit to furrow. But the farmers are not able to afford for the pneumatic system because of high initial cost. So farmers feasible seed drill which can place the seeds in furrow, reduces the operation and cultivation cost has to be developed.

By considering all the above factors, an animal drawn onion seeder was developed and evaluated for its performance and percentage germination of seeds was also tested.

Material and Methods

Study area

The experiments were conducted at the Engineering section of Department of Agricultural Engineering at IIHR, Bangalore.

Raw material

Good quality onion seeds of "Arka Kirthiman" variety was selected. A sample of 260 g of this variety was used for determining various properties of onion seeds.

Development of an animal drawn onion seeder

Fig. The CAD Diagram of animal drawn onion seeder was attached on pdf

Design of ground wheel and no. of holes on the drum

Wheel diameter = 550 mm

Circumference = $\pi d = 3.14 \times 550 = 1727$mm

For 2 kmph of forward speed, ground wheel makes = 2000/17.27 = 1158 revolution /h = 20 rpm

Area covered =1.6×2000 = 3200 m²/hr = 53.3 m²/min

Drum

Total no. of drums is 14 and each drum diameter is 15 cm. It has 29 holes per each drum. Hole diameter is 3.4 mm and drum to drum distance 4cm. No. of holes in the drum is calculated by

$n=\pi D/x$

Where,

n= No. of holes on the drum.
D= Ground wheel diameter.
x = Hole to hole spacing.
D= 55 cm
x=6 cm
$n=\pi D/x=3.14\times55/6$
n =28.78
n = 29 holes

Drums were made up of MS discs of 15cm diameter & thickness 8mm. Fourteen drums of each Drum perimeter 47.1 cm and diameter 15 cm were fabricated. It has 29 holes per each drum. In each drum 14 holes (hole to hole distance 3.42 cm) in one row and 15 holes (hole to hole distance 3.2 cm) in one row as shown in plate 4. Two M. S discs were separated by spaces in between of length 5cm. A fiber sheet of length equal to circumference of discs (4.8cm), width equal to length of spaces (6.8cm) and thickness 4mm was selected. The selected fiber sheet was wrapped around and screwed to the two discs.

Drum to drum spacing 4 cm as shown in fig 1. The entire assembly is attached in the middle of the frame. In order to rotate the drum, the seeder is pulled in forward direction.

Frame

It is made of MS hollow square pipe of 2×2 inch size and 5 mm thickness. Length and width of frame is 1.95 m and 38cm, respectively. Other parts of seeder are fitted with the frame as shown in Figure 2.

Ground wheel

M.S flat of length 160cm and thickness of 5mm was selected. Flat was rounded to form a circular wheel of equal dimensions were fitted at either side of shaft of M. S the bearings attached to the frame at a distance of 20 cm to close the dropped seed from the holes of drum.

Handle

The seeder has a handle of 2.97 m length and 28.55 mm diameter of for easy pulling. It is made of M. S. square pipe used for directing & guiding the drum seeds.

Pegs

12 mm diameter of M. S square rod was used for making 22 pegs, each peg length 38 cm, peg to peg spacing 6 cm. These pegs were attached to the frame as shown in fig 3. This peg system is groove type adjustable system. To cover the seeds with the soil for improving the seed germination on field.

Shaft

Two shafts were taken one shaft length is 186 cm and other shaft length is 22.5 cm, diameter 32 mm and 28 mm respectively. It is made up of M.S. rod. To transmit the power ground wheel to the drums. 25 mm, 4 bearings were used for easy rotation and turning purpose.

Fiber sheet

It is used to closed the gap between 2 drum plates for seed dropping. The seeds dropping purpose, there are 29 holes were made on zig zag (Diagonally) position, in between hole to hole distance is 2.5 cm. The fiber sheet thickness is 4 mm, length is 48 cm and width is 6.8 cm for each drum.

Experimental Design

The experiment was carried out in IIHR at Agricultural engineering section. Experimental field type of soil was red. The field was completely designed into six plots. There were six treatments with each one replication. Site of the each plot was 1.6 m width and 20 m length. The different treatments taken up for comparison were

P_1 = Single row holes (14holes) with one cup (56.84g).

P_2 = Double row holes (29holes) with one cup (56.84g).

P_3 = Single row holes (14holes) with two cups (113.68g).

P_4 = Double row holes (29holes) with two cups (113.68g).

P_5 = Single row holes (14holes) with three cups (170.52g).

P_6 = Double row holes (29holes) with three cups (170.52g).

Field preparation

The field was ploughed using a disk plough, crumbles were broken by spike tooth harrow and leveling was done with help of levelers. The field was laid out in six experimental plots. The plots were allotted for different treatments as shown in Fig 5.

Crop

The experiment was conducted on refined onion seed crop. The variety of crop is Arka kirthiman was sown in the field. The duration of crop was 120 days. Seed rate was 8-10 kg/ha. The crop was raised during the early season (October-January) as shown in fig 8.

Results and Discussion

The results of the present study entitled "Development of an animal drawn onion seeder" conducted at the Section of Agricultural Engineering, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore-560089 and in the Laboratories of IIHR, Bangalore, during the year 2013-2014 are given below. The machine parameters

were standardized by taking various trials at different no. of holes. The onion sowing machine was analyzed for six field treatments. After field test, 14 holes gave higher germination percentage and plant to plant spacing was 6 – 8 cm, row to row spacing was 7.5 – 8 cm.

Development of an animal drawn onion seeder

The machine parameters were standardized by taking various trials with single row holes (14) and double row holes (29) with ⅓rd, ½th and ⅔rd volume of seed filling in the drums. The onion sowing machine was analyzed for six field treatments.

The machine parameter of 15 cm diameter drum was standardized. After field test,14 holes with ⅔rd of the volume of filling were gave higher germination percentage and plant to plant spacing was 6.5 - 8 cm, row to row spacing was 7.5- 8 cm.

Performance evaluation of developed onion seeder

The animal drawn onion seeder was evaluated to study the field capacity ha/hr, seedlings in square meter, seed germination per cent age, seed to seed and row to row spacing, cm. The drum has holes in the two rows spaced at a distance of 2.5 cm.

One row has 14 holes and another row has 15 holes. The effect of these holes opening on the density of the crop and germination was determined by filling the drums with ⅓rd, ½, ⅔ rd volume.

Experimental field results

After sowing the seeds, the seeds were germinated. The seedlings were counted in one square meter per each replication. The counted readings were as shown in the table 2 and a graph in plotted between volume of filling and seedlings/sq.m.

Initially field in divided to six plots. Each plot was of co m length and 1.6 m width. seeder in tested for no. of plants in 1 m^2 area. seeder is operated in the first and second plots with one row of holes open (i.e., 14 holes) and two rows of holes opened (i.e., 29 holes) respectively with ⅓ rd of seed filled in drum.

Seeder was operated in the third and fourth plots with one row of holes open (i.e., 14 holes), another row was closed (i.e., 15 holes) and both rows open (29 holes) respectively with ½ of seed filled in drum. Again seeder in operated in the fifth and sixth plots with one row of holes open (14 holes), another row closed (15 holes) and both rows open (29 holes) respectively with ⅔rd of seed filled in the drum.

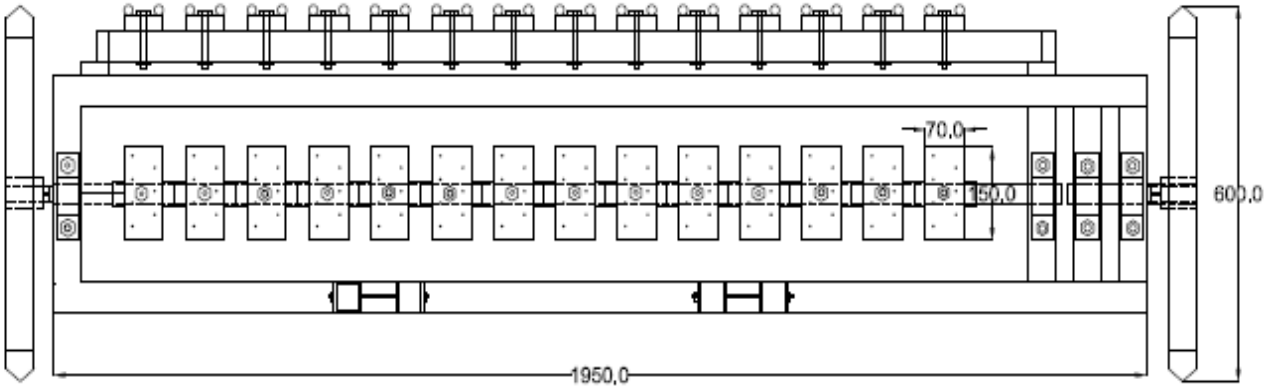
A square meter wooden frame was randomly placed at 5 different places on the germinated seedlings in each plots termed as replication (R1). Five such type replications were taken and recorded in each experimental plot**.**

From the above graph it in clear that, seeder with two rows opened and with ⅓rd of volume of drum filling used good amount of seeds. Which was examined in the second plot compared to the other plots.

An average of seedlings germinated in the second plot (29 holes open with ⅓rd drum filling) was observed as 150.

Germinated seedlings, row to row spacing (Table 4)

Since there is no any furrow opener provided to the seedlings there is a chance of spinage and on alignment of seedlings in the row, Hence row to row spacing of the seedlings were also replicated and represent in table 4.



LEGENDS		
S.NO.	PARTS	MATERIAL
1	WHEELS	M.S.FLAT
2	SHAFT	M.S.ROD
3	SEED DRUM	M.S.PLATE
4	PEGS	M.S.ROD
5	BUSHES	M.S.ROD
6	SQUARE PIPE	MILD STEEL
7	FRAME	M.S.SQUARE PIPE
8	BEARINGS	CAST IRON

Fig. Top View

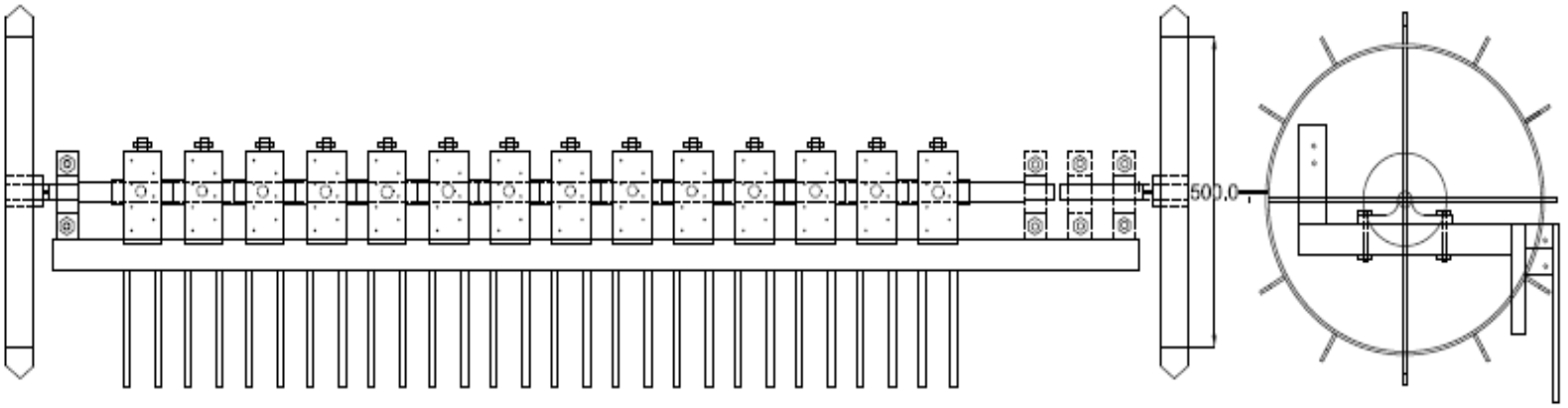


Fig. Front View

Fig. Side View

All dimensions are in mm
Scale - 1: 1

Title : Animal drawn onion seeder

Table.1 Specifications of animal drawn onion seeder

Specifications of onion seeder	
Description	Onion sowing machine
Sources of power	Two bullocks
Suitable crop	Onion
Principle	Vertical plate mechanism.
Onion seeds dia, mm	3.2
Onion seeds colour	Black
No. of drums	14 (dia - 15 cm, width - 5 cm)
Drum to drum distance	4 cm
No. of holes	14
Hole dia, mm	3.4
Plant to plant spacing(cm)	6.14-8.7
Row to row spacing(cm)	7.2 - 9.15
Main frame	195 x 38 (2x2 inches square pipe)
Working width of implement(cm)	160
Ground wheel diameter(cm)	50
Field capacity(ha/hr)	0.32
Cost of machine	Rs. 16,100.

Table.2 Germinated seedlings in one square meter.

Volume of filling							
		⅓		½		⅔	
No. of holes							
		Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)
Seedlings/sq.m							
	R1	54	181	52	119	64	115
	R2	30	117	50	83	82	111
	R3	71	163	48	126	75	126
	R4	60	151	64	123	89	164
	R5	47	140	70	92	89	139
Average		52.4	150.4	56.8	108.6	79.8	131
Standard error of deviation		15.31	24.1	9.65	19.67	10.56	21.41
Standard error of mean		6.85	10.77	4.31	8.79	4.72	9.57
95 % of confidential limit		38.974 - 65.826	129.29 - 171.509	48.35 - 65.25	91.37 - 125.83	70.55 - 89.05	112.243 - 149.757

Table.3 Germinated seedlings, plant to plant spacing

Volume of filling							
		⅓		½		⅔	
No. of holes							
		Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)
Plant to plant spacing(cm)							
	R1	6.6	4.18	14.3	8.33	8.33	6.25
	R2	7.46	5.00	9.56	9.08	6.14	5.88
	R3	5.81	6.13	7.04	6.73	7.21	5.88
	R4	10.875	6.78	9.45	6.25	8.33	6.67
	R5	9.54	4.7	12.5	7.69	8.33	6.67
Average		8.057	5.358	10.57	7.616	7.668	6.67
Standard error of deviation		2.1	1.07	2.84	1.15	0.98	0.395
Standard error of mean		0.94	0.48	1.27	0.514	0.438	0.176
95 % of confidential limit		6.215 - 9.89	4.417 - 6.298	8.085 - 13.059	6.609 - 8.617	6.81 - 8.526	6.325 - 7.015

Table.4 Germinated seedlings, row to row spacing

Volume of filling							
		⅓		½		⅔	
No. of holes							
		Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)	Single row holes(14)	Double row holes(29)
Row to row spacing(cm)							
	R1	7.54	4.895	16.67	8.33	7.14	9.09
	R2	7.23	5.47	9.75	9.09	7.53	7.5
	R3	7.91	7.46	14.00	7.15	10.00	7.69
	R4	8.04	5.88	8.00	9.09	7.38	7.31
	R5	9.00	6.67	9.33	6.2	7.69	7.14
Average		7.944	6.073	11.55	7.97	7.972	7.746
Standard error of deviation		0.67	1.01	3.65	1.27	1.16	0.78
Standard error of mean		0.3	0.451	1.63	0.567	0.518	0.35
95 % of confidential limit		7.356 - 8.532	5.189 - 6.976	8.355 - 14.745	6.859 - 9.081	6.957 - 8.987	7.06 - 8.432

Table.5 Specifications and cost of developed animal drawn onion seeder

Sl. No.	Material	Size	Quantity	Total cost of materials (Rs)
1.	Mild steel Frame	1950 x 380×5 mm	10 kg	600
2.	Mild steel Shaft	1860 x 32 mm 225×32 mm	1 No 1 No	600
3.	Mild steel bush	20×35 mm 75×50 mm	28 No 2 No	240
4.	Mild steel Ground wheel	1570 x 500 x 5mm	2 No	1800
5.	Drums	150 mm Ø	14No	2100
6.	Fiber sheet	471×70 mm	14 No	4600
7.	Mild steel square pipes	10'	2 No	1000
8.	Mild steel pegs	380×12 mm	28 No	300
9.	Mild steel spacer	50×40 mm	14 No	280
10.	MS-angle	1700 x 25 x 5 mm	4 kg	300
11.	Bearings	25 mm	4 No	1000
12.	Plastic caps	20×30Ø mm	14 No	280
13.	Bolts, nuts and miscellaneous	6,8,10,12 mm	-	500
Total cost			-	13,600
Labour cost			-	2500
Total cost of machine			-	**16,100**

Fig.1 Drums

Fig.2 Frame

Fig.3 Peg system

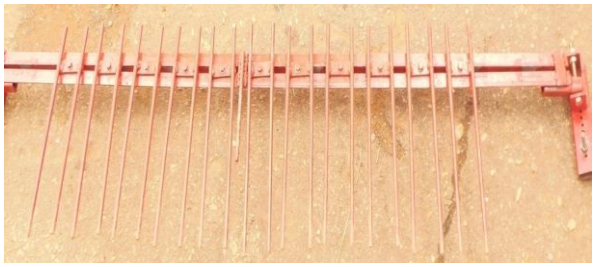


Fig.4 Animal drawn onion seeder front, top and side views

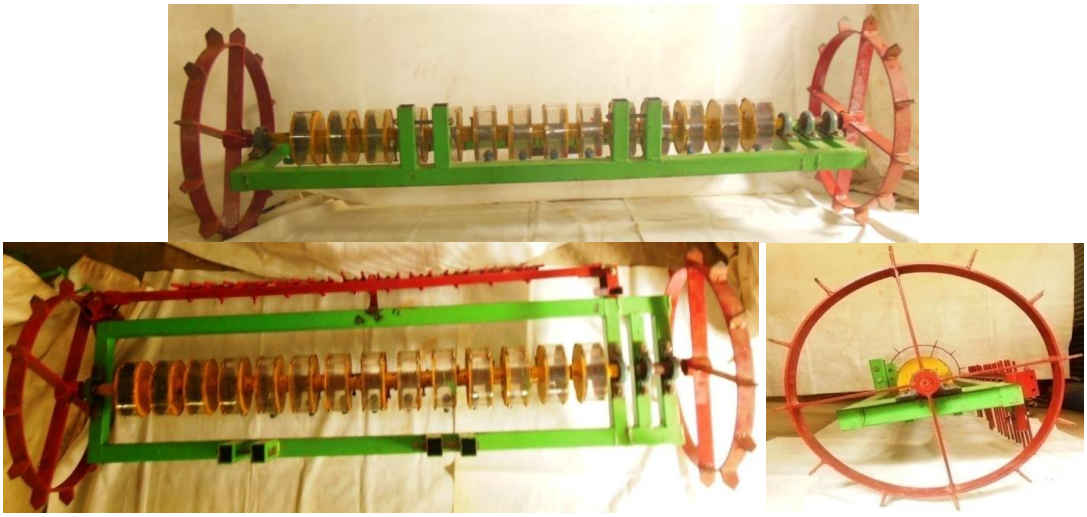


Fig.5 Field layout plan

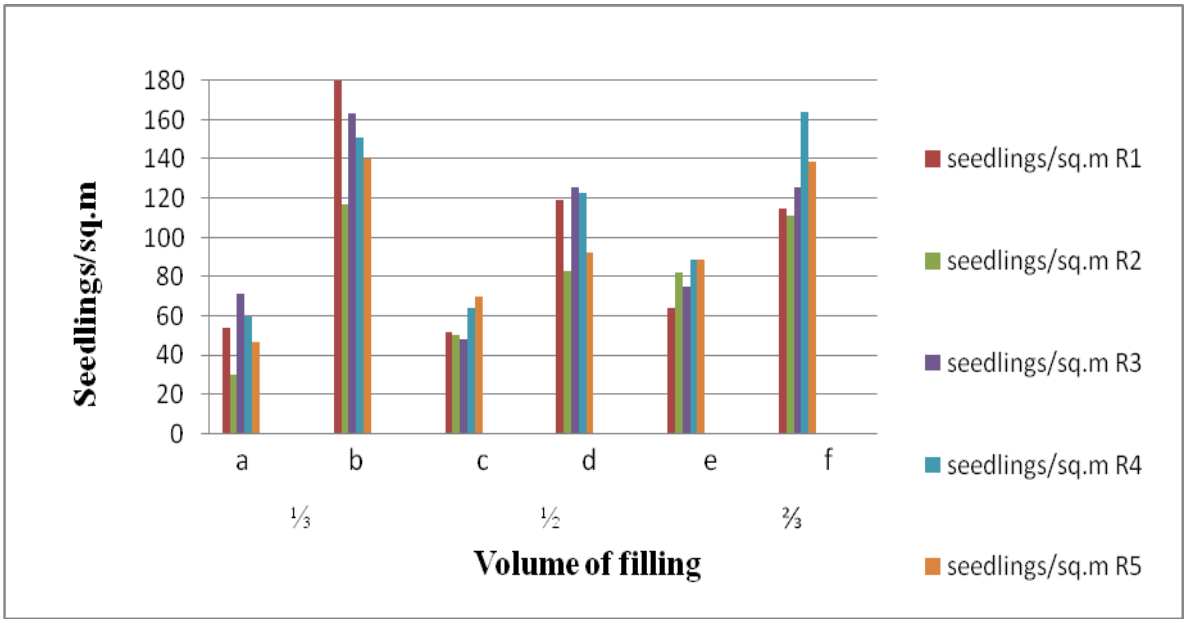
Volume of filling					
⅓(single cup)		½(two cups)		⅔ (three cups)	
Plot1	Plot2	Plot3	Plot4	Plot5	Plot6
Single row holes(14holes)	Double row holes(29holes)	Single row holes(14holes)	Double row holes(29holes)	Single row holes(14holes)	Double row holes(29holes)
20 m					
1.6m					

Fig.6 Field layout

Fig.7 Weeding in plots

Fig.8 Onion crop in laid plot

Fig.9 Seedlings per square meter for replications

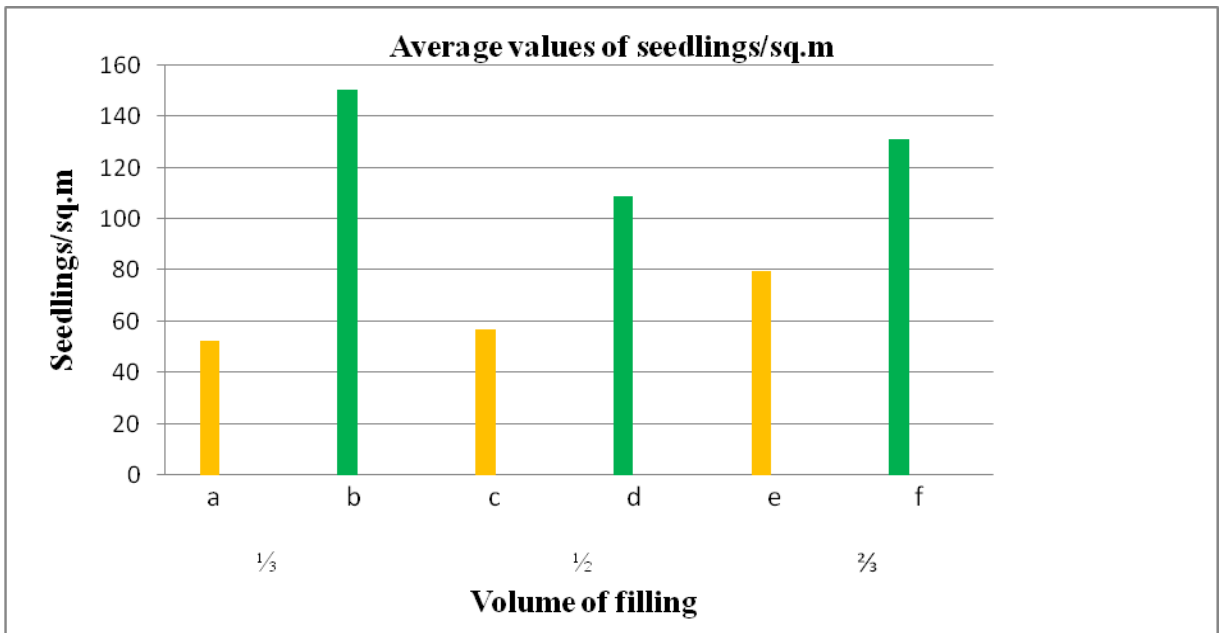


a. Sowing with one row (14) when 1/3rd of drum is filled, **b.** Sowing with two rows (29) when 1/3rd of drum is filled

c. Sowing with one row (14) when 1/2 of drum is filled, **d**. Sowing with two rows (29) when 1/2 of drum is filled

e. Sowing with one row (14) when 2/3rd of drum is filled, **f.** Sowing with two row (29) when 2/3rd of drum is filled

Fig.10 Average values of seedlings per square meter for replications



a. Sowing with one row (14) when 1/3rd of drum is filled, **b.** Sowing with two rows (29) when 1/3rd of drum is filled

c. Sowing with one row (14) when 1/2 of drum is filled, **d**. Sowing with two rows (29) when 1/2 of drum is filled

e. Sowing with one row (14) when 2/3rd of drum is filled, **f.** Sowing with two row (29) when 2/3rd of drum is filled

Fig.11 Plant to plant spacing for replications

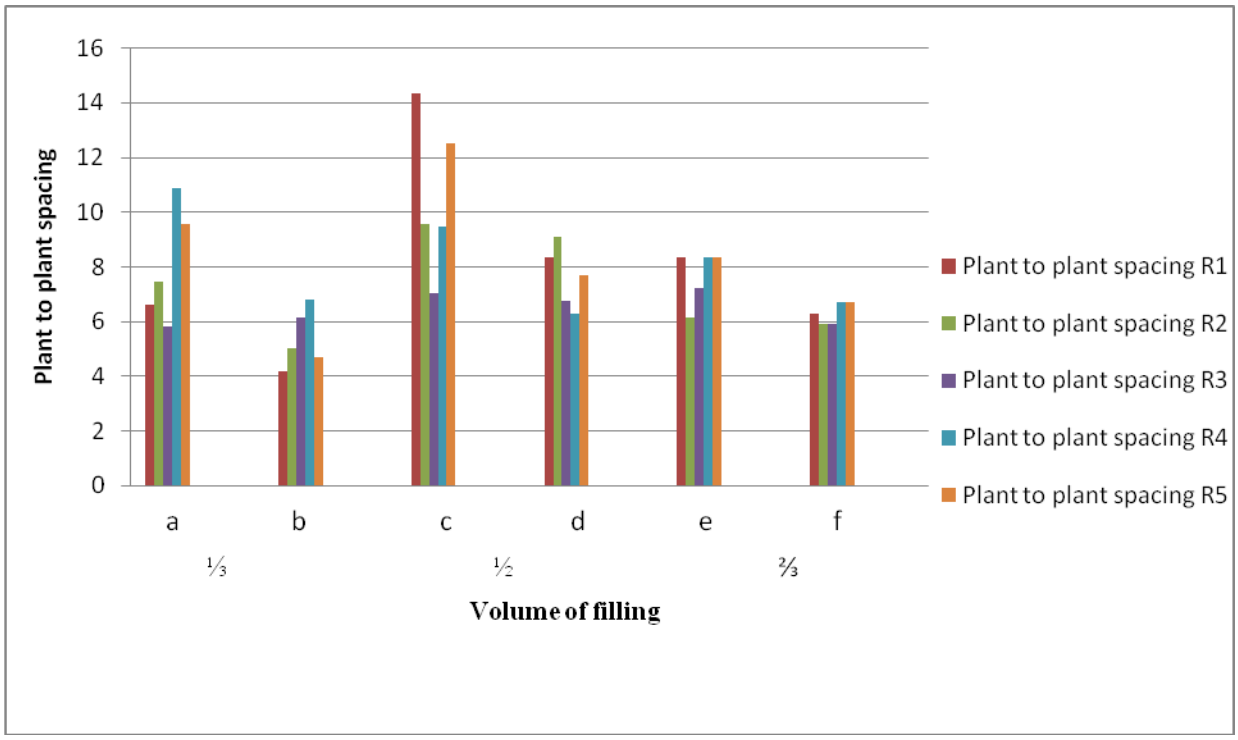
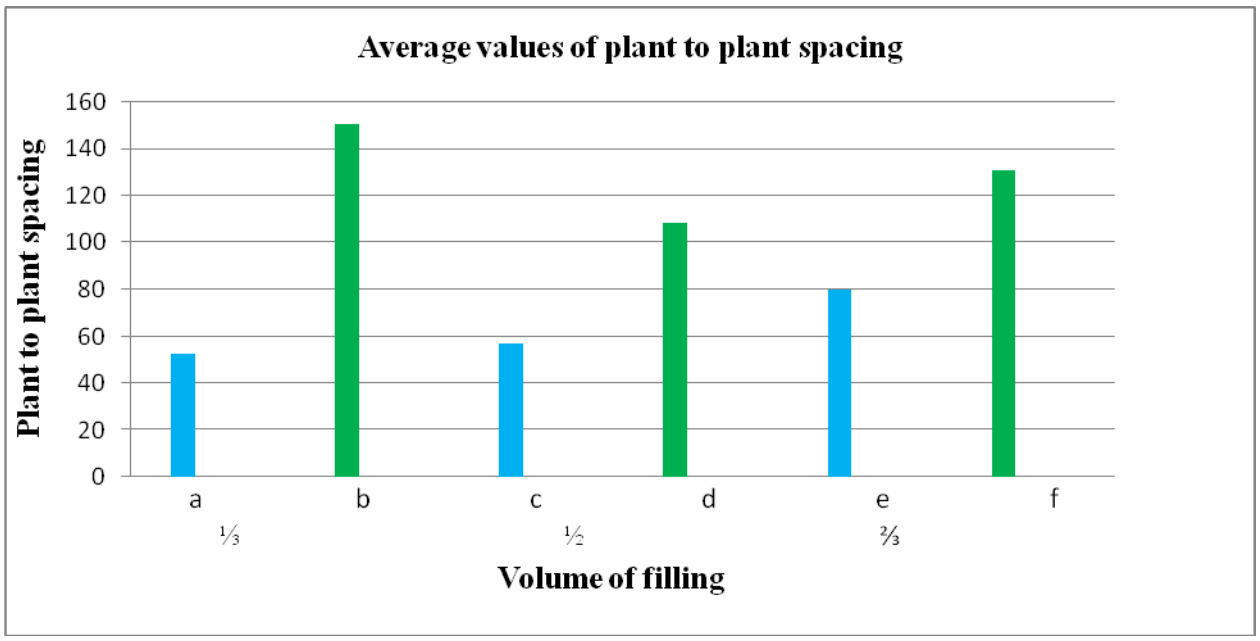


Fig.12 Average values of plant to plant spacing



a. Sowing with one row (14) when 1/3rd of drum is filled, **b.** Sowing with two rows (29) when 1/3rd of drum is filled

c. Sowing with one row (14) when 1/2 of drum is filled, **d.** Sowing with two rows (29) when 1/2 of drum is filled

e. Sowing with one row (14) when 2/3rd of drum is filled, **f.** Sowing with two row (29) when 2/3rd of drum is filled

Fig.13 Row to row spacing for five replications

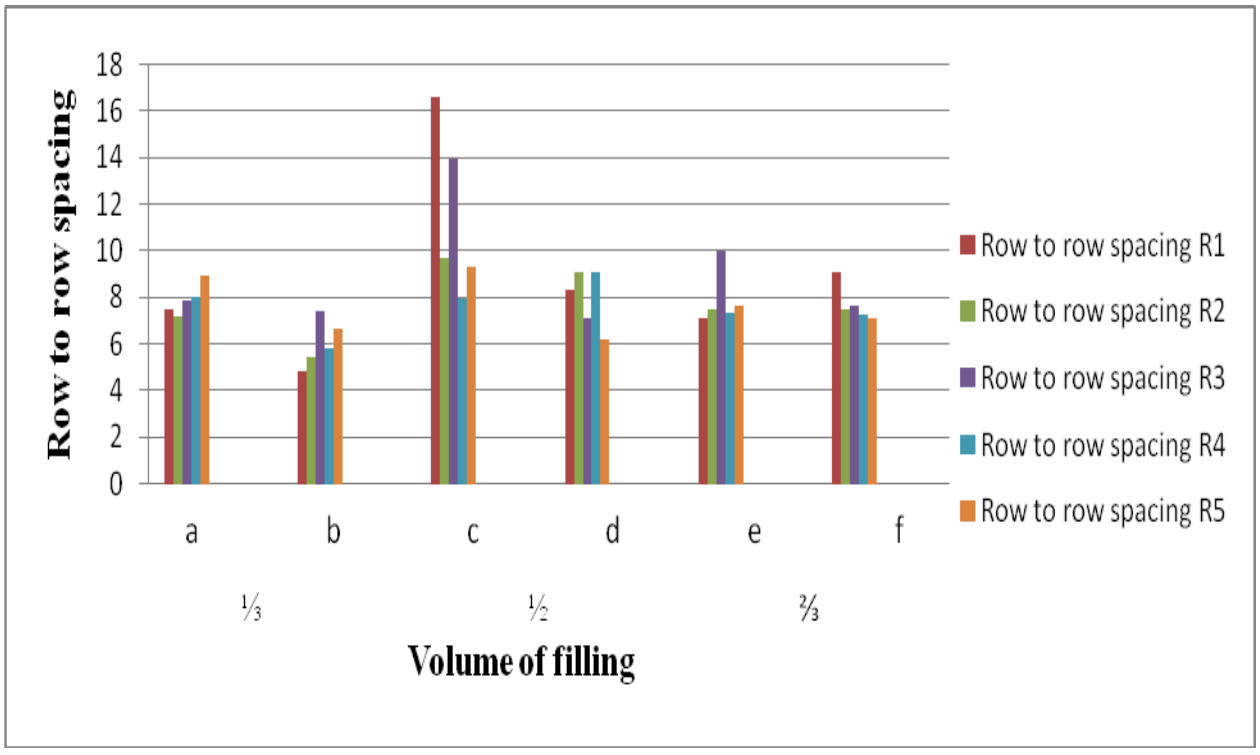
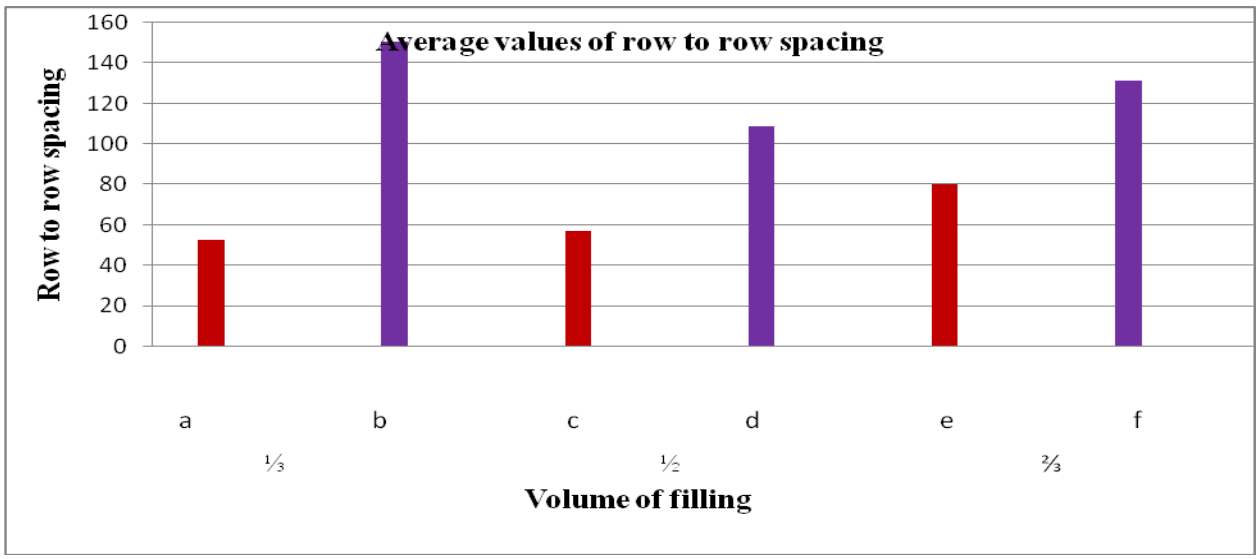


Fig.14 Average values of row to row spacing



Cost economics

The economics of the developed seeder and the cost incurred to sowing the seeds were determined taking into account the fixed cost, it includes Material cost, Fabrication cost and Salvage value and Variable costs, is includes Labour cost. The total cost of the machine was Rs. 16, 100. It is shown in table 5. Developed animal drawn onion seeder consists of two ground wheels of diameter 50 cm, 14 no. of drums provided with 29 no. of holes mounted on the rotating shaft. The entire attachment was fixed on the frame.

One wheel rotates the metering unit (14 drums) and another wheel is independent which helps in turning the machine. 28 no. of pegs were welded to the frame to assist in covering the dropped seeds. Total length of the machine 1.95 m and width is 38 cm. Physical and mechanical properties of onion seeds such as geometric mean diameter, sphericity, bulk density, true density, co-efficient of static friction determined by various methods.

The developed animal drawn onion seeder was field tested in red soil in the experimental plot at IIHR, Bangalore. The field area was divided into 6 no. of plots with length 20 m and width of 1.6 m. No. of germinated seedlings in a square meter, plant to plant spacing and row to row spacing were replicated 5 times in each plot with ⅓rd, ½, ⅔rd volume of filling in drums.

In no. of seedlings/sq.m, ⅓rd double row holes (29) is more (150 no.) and single row holes (14) is less (52). In plant to plant spacing, ½ filling single row holes gives more spacing (10.57 cm) and ⅓rd double row holes (29) gives less spacing (5.358 cm). In row to row spacing, ½ filling single row holes gives more spacing (11.55 cm) and ⅓rd double row holes (29) gives less spacing (6.073 cm).

The seeder with single row holes open with ⅔ rd of drum filling was selected to drop the onion seed in the rainfed area. The recommended onion seedlings should be in the range of 75 to 80 per sq.m with a row spacing of 7.5 to 8 cm and plant spacing of 6 to 8 cm. The above recommendation was alignment with single row holes (14) opened with ⅔ rd of drum filling.

Field capacity of the seeder with single row holes (14) open and ⅔ rd of drum filling were 0.32 ha/hr. Row to row spacing was 7.9 cm with a germination per centage of 97.3%. The cost of the animal drawn onion seeder was Rs. 16,100

Cost Economics of Animal Drawn Onion Seeder

Fixed cost

a. Material cost + Fabrication cost (C) = Rs. 16,100

b. Salvage value (S) @ 10% of total cost machine = Rs. 1610

Operational cost

a. Annual use (U) (Expected operational hours) = 720 h

b. Expected life years (L) = 10 years

Fixed cost

Depreciation (D)

$$D = \frac{C - S}{U\ L} = \text{Rs.2.01/h}$$

Interest on capital investment @ 12 % per annum on average price (I)

$$I = \frac{C + S}{2\ U} \text{ X } 0.12 = \text{Rs. } 0.295/h$$

Repairs/maintenance cost @ 2 % (R)

$$R = \frac{C}{UL} \text{ X } 0.02 = \text{Rs. } 0.045/h$$

Total fixed cost (D + I + R) = Rs.2.35/h

Operational cost/Variable cost

Labour cost @ ₹ 250 per day (8 hours) per person or Rs. 31.25/h

Total variable cost (b) =Rs. 31.25/h

Total cost of operation (A) = Total fixed cost + Total variable cost = Rs (2.35+31.25)/h = Rs. 33.6/h

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How to cite this article:

Gireesh, B., G. Sujatha, B. Sunitha, B. Rajkiran and Ramana, M.V. 2017. Modification and Performance Evaluation of Animal Drawn Onion Seeder. *Int.J.Curr.Microbiol.App.Sci.* 6(10): 2749-2763. doi: https://doi.org/10.20546/ijcmas.2017.610.323