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Performance Evaluation of Aqua Planter for Groundnut Crop

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A B S T R A C T

Dry land agriculture plays an important role in the progress of Indian agriculture. The farmers are struggling to maintain timeliness in different unit operations of groundnut to take advantage of favorable situation in dry land conditions of Andhra Pradesh state. It is observed that the yields are expected to decrease by 10-15 per cent, if sowing is delayed by one week, under rain-fed situation. It is absolutely crucial for the seeds that moisture be available in the first few days itself after sowing to achieve 100 per cent germination. Aqua sowing is the simultaneous sowing of seeds and delivery of an equitable quantum of water, just right for the seeds to germinate irrespective of whether it rains or not for the next few days. This is a new technology developed for the benefits of dryland farmers and specially for sowing of seeds during contingency season of delayed monsoon. Seed rates for the groundnut was 105.47, 108.46, 118.55 kg ha^{-1} with vertical, inclined and horizontal plate seed metering mechanisms respectively. The vertical plate metering mechanism has been selected for sowing in the field. The highest application of water in a test plot of 30 m x 30 m was found to be 120 lit/min. The field capacity was found to be 0.145 ha h^{-1} for groundnut with field efficiency of 88.90 per cent at an average speed of 2.72 kmph for an aqua planter. The highest pod yield was found to be 619.38 kg ha^{-1} with discharge rate of 120 lit/min. The cost of sowing with tractor drawn aqua planter was Rs. 751.42 per hour.

Introduction

Agriculture is one of the most important sectors of Indian economy both in terms of gross national product and number of productive workers employed. Dry farming or dry land farming is a practice of growing a profitable crop without irrigation in areas, which receive an annual rainfall of 500 mm or even less. Dry lands contribute more than 40 per cent food grains (80 per cent maize, 95 per cent of pearl millet and sorghum). About 95 per cent of pulses and 75.5 per cent of oilseeds are also grown in these areas. Thus, dry lands and rain fed farming will continue to play a dominant role in agricultural production. Groundnut (*Arachis hypogaea* L.) is the major oil seed crop in India and it plays a major role in bridging the vegetable oil deficit in the country. Groundnut is an important protein

crop in India, it raised mostly as a rain fed Kharif crop, being sown from May to June, depending on the monsoon rains. In some areas, or where the monsoon is delayed, it is sown as late August or early September (Madhusudhana, 2013).

The crop can be grown successfully in places receiving a minimum rainfall of 500 mm and a maximum rainfall of 1250 mm. The area under groundnut crop is 4.70 M ha, which occupies 45% area and 55% of the total oil seeds production i.e., 6.60 MT in India (Economic Survey of India, 2015). The area under Groundnut alone accounted for 77.21% of the total area under oil seeds during 2014-15 in Andhra Pradesh (Directorate of Economics and Statistics, 2015). The effectiveness of rainfall in crop production depends mainly on commencement of sowing rains and amount and distribution of rainfall during the season (Sahu *et al.,* 2004).

It is absolutely crucial for the seeds that moisture be available in the first few days itself after sowing to achieve 100 per cent germination. Aqua sowing is the simultaneous sowing of seeds and delivery of an equitable quantum of water, just right for the seeds to germinate irrespective of whether it rains or not for the next few days. This is a new technology developed for the benefits of dryland farmers, and specially for sowing of seeds during a contingency season of delayed monsoon.

Materials and Methods

Laboratory evaluation of different metering mechanisms

The laboratory experiments were conducted to calibrate different seed metering mechanisms for groundnut with commercially available tractor drawn planters at Agricultural Research Station, Ananthapuramu. The specifications of commercially available seed metering mechanism were reported in Table 1.

Groundnut

The evaluation of groundnut seed was conducted under laboratory conditions to determine the discharge rate (seed rate).

Determination of seed rate for different seed metering mechanisms

It was necessary to calibrate the planters before conducting field test for groundnut seeds to find the desired seed rate. The planters were calibrated by the standard method (as per BIS test code 6316: 1993).

Performance of tractor drawn aqua planter

Tractor drawn aqua planter was developed at Agricultural Research Station, Ananthapuramu. It consists of

Main frame
Seed hopper
Seed hopper holding pipes
Seed metering mechanism
Seed tube
Furrow opener
Power transmission system
Depth control wheels
Water tank (Fig. 1)

Main frame

Main frame of planter was made of MS angular plates of size 1500 x 80 mm. All the other parts of planter were attached to main frame.

Seed hopper

The seed hopper was made of MS sheet. The overall dimensions of the hopper were 300 x 230 x 350 mm. An adjustable gate was

provided below the hoper to allow the seeds into metering mechanism.

Seed metering device

A vertical plate seed metering device was used to meter the seed. Diameter of each plate is 96 mm with thickness of 13 mm for groundnut and 7 mm for red gram and having 10 cells around its periphery.

Seed tube

Seed tube is made of plastic and having diameter of 4.45 cm. The main function of seed tube is to deliver seed from metering device to boot.

Furrow opener

Shovel type furrow opener was used as furrow opener and which was made of MS flat plate 60 mm width, 5mm thickness and length 280 mm. It was attached to one end of tyne with bolts and nuts.

Power transmission system

A peg type ground wheel was provided for power transmission. Sprockets along with chain were used to transmit power from ground wheel to seed metering device.

Depth control wheels

Two depth control wheels were attached on each side of the planter. The wheels provide balance to the planter and helps in maintaining proper depth of sowing.

Water tank

An elliptical shaped about 4000 liters capacity of tank has been used for water application while sowing. The overall dimensions of the tank were 2750 x 1720 x 1220 mm.

Calibration of water application system

Calibration was done in the laboratory, to determine the time required for emptying tank when valve is fully open.

Also determined the valve positions for discharging of water at 60, 90 and 120 L/min respectively.

The application rate of water per ha was calculated by considering effective field capacity. Water application rate is calculated by using formula given below.

$$\text{Application rate, L/ha} = \frac{\text{Volume of water applied}}{\text{Area of test plot}}$$

Performance evaluation of tractor drawn aqua planter

The performance of tractor drawn aqua planter was evaluated under field conditions. The parameters such as soil, operational, sowing, crop and yield parameters were observed during the field tests. The specifications of the tractor drawn aqua planter are presented in Table 2.

Machine and operational parameters

Speed of operation

To determine the speed of operation, planter was operated on a row of 25 m length. A stop watch was used to record the time for the planter to traverse the marked run so that the speed of travel was computed in m s^{-1}.

Effective field capacity

It is the actual area covered by the planter based on its total time consumed and actual working width under field conditions.

Field capacity (ha h^{-1}) = Actual area covered/total time consumed

Theoretical field capacity

Theoretical field capacity is the rate of field coverage of the implement, based on 100 per cent of time at the rated speed and covering 100 per cent of its rated width.

The theoretical field capacity was determined using the following formula.

$$\text{Theoretical field capacity, ha h}^{-1} = \frac{Width\ (m) X\ Speed\ (km/h)}{10}$$

Field efficiency

Field efficiency is the ratio of effective field capacity to theoretical field capacity.

It was determined by the following formula (Ashok *et al.*, 2012)

$$\text{Field efficiency, \%} = \frac{Effective\ filed\ capacity,\ (ha/h)}{Theoretical\ field\ capacity,\ (ha/h)} \text{ X } 100$$

Sowing parameters

Seed rate

The seed rate was determined by taking the weight of seed before and after sowing operation.

Then subtracted the final weight of seed from initial weight of seed so that the seed rate was obtained and the results were expressed in terms of kg ha^{-1}.

Depth of sowing

Depth of sowing of seeds was determined with the help of steel scale of 0.3 m.

Twenty observations were taken for each plot and their mean was calculated to represent the depth of sowing.

Seed to seed spacing

Seed to seed spacing was measured by a steel scale of 0.30 m length after sowing. The soil was removed carefully without disturbing the seeds at minimum five random places taken for three different discharge rates 60, 90 and 120 L/min in a row and the mean was determined to represent seed to seed spacing.

Crop parameters

Average plant population

The average plant population was determined by counting number of plants per square meter at five random places and the mean value represented the average plant population.

Seed to seed spacing

Seed to seed spacing was measured by a steel scale of 0.30 m length after sowing. The soil was removed carefully without disturbing the seeds at minimum five random places taken for three different discharge rates 60, 90 and 120 L/min in a row and the mean was determined to represent seed to seed spacing.

Pod yield

Pod yield was determined from 1 m^2 area. Five random observations were taken from field and thoroughly dried in sun. After completion of sun drying, the pods are separated from plants and the weight of pods for groundnut seed were recorded and converted to kg ha^{-1}.

Cost economics

The cost economics of planter was estimated by considering fixed and operational costs of planter and power source. The cost of operation is based on the prevailing market rates during the season and location. (IS 9164:1979).

Results and Discussion

The results have been presented under the following heads:

Seed rate of groundnut

Seed rates for the groundnut seed observed were 105.47, 108.46 and 118.55 kg ha^{-1} respectively for the different seed metering mechanisms viz. vertical plate, inclined plate and horizontal plate metering mechanisms respectively in the calibration test. The results are presented in Table 3 to 5.

Water application system

The results of aqua planter for groundnut are given in Table 6. The average discharges of water taps are adjusted for 60, 90 and 120 L/min. The application rate of water in a test plot of 30 m x 30 m was found to be highest for 120 L/min i.e. 49655.17 liters at an average speed of 2.72 kmph groundnut respectively.

Field performance of the aqua planter

The aqua planter was field tested for its machine parameters and crop parameters in research field of plot 30 x 30 m^2 at Agricultural Research station, Ananthapuramu.

The field performance of the Aqua planter like the effective field capacity and field efficiency was observed as 0.145 ha/h and 88.90 per cent respectively. During the effective field capacity was lower. It was observed during field operation, the care taken to reduce the time for turning, clogging and adjustments of the aqua planter resulted in higher field efficiency (Table 7).

Further it was observed that depth of seed placement was 51 mm with row to row spacing of 228 mm. The seed rate was found to be 105.47 kg/ha. The pod yield obtained was 619.38 kg/ha and the cost of tractor drawn aqua planter is Rs. 751.42 per hour.

The performance of tractor drawn aqua planter for groundnut is developed under Agricultural Research Station, Ananthapuramu. An attempt was made to evaluate the performance of aqua planter under field conditions and study of the performance of existing seed metering mechanisms groundnut seeds under laboratory conditions various parameters i.e. seed rate, water application rate, field efficiency, seed to seed spacing, depth of sowing and crop yield were studied. Following were the conclusions that are drawn from the study

Table.1 Specifications of the commercially available seed metering mechanisms

S. No	Seed metering mechanism	No. of furrow openers	Row spacing (m)	Operating width (m)	Dimensions of planter/seed drill (lxbxh) (cm)
1	Inclined plate	8	0.30	2.4	255x97x110
2	Horizontal plate	8	0.30	2.4	255x97x128
3	Vertical plate	8	0.30	2.4	255x98x157

Table.2 Specifications of tractor drawn aqua planter

S. No	Particulars	Specifications
1.	Power source	>40 H.P tractor
2.	Number of furrows	5
3.	Row to row spacing	30 cm
4.	Effective working width	150 cm
5.	Type of seed metering mechanism	Vertical plate
6.	Overall height and width	145x65x120 cm
7.	Seed box capacity	8 kg
8.	Depth of sowing for groundnut and red gram	5-7 cm and 5-6
9.	Seed to seed spacing in a row	10 cm
10.	Type of furrow opener	Shovel type
11.	Water tank capacity	4000 liters
12.	Cost	Rs. 1,00,000/-

Table.3 Calibration of the vertical plate metering mechanism for groundnut

Test no.	Weight of seed discharged in 128 revolution of ground wheel								Weight of seed collected from all furrow openers (kg)	Seed rate (kg ha^{-1})	Average seed rate (kg ha^{-1})
	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8			
1	0.42	0.52	0.49	0.47	0.69	0.49	0.56	0.57	4.21	105.12	105.47
2	0.43	0.49	0.47	0.46	0.71	0.44	0.53	0.65	4.18	104.37	
3	0.45	0.55	0.48	0.43	0.67	0.48	0.54	0.63	4.23	105.62	
4	0.44	0.53	0.46	0.45	0.67	0.47	0.56	0.63	4.21	105.12	
5	0.45	0.54	0.47	0.47	0.68	0.48	0.55	0.65	4.29	107.11	

Table.4 Calibration of the inclined plate metering mechanism for groundnut

Test no.	Weight of seed discharged in 128 revolution of ground wheel								Weight of seed collected from all furrow openers (kg)	Seed rate (kg ha^{-1})	Average seed rate (kg ha^{-1})
	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8			
1	0.45	0.54	0.52	0.51	0.5	0.71	0.51	0.59	4.33	108.11	108.46
2	0.46	0.56	0.51	0.52	0.52	0.72	0.52	0.58	4.39	109.61	
3	0.46	0.55	0.51	0.5	0.5	0.71	0.53	0.59	4.35	108.61	
4	0.45	0.54	0.5	0.52	0.5	0.73	0.52	0.58	4.34	108.36	
5	0.44	0.55	0.51	0.5	0.51	0.72	0.51	0.57	4.31	107.61	

Table.5 Calibration of the horizontal plate metering mechanism for groundnut

Test no.	Weight of seed discharged in 128 revolution of ground wheel								Weight of seed collected from all furrow openers (kg)	Seed rate (kg ha^{-1})	Average seed rate (kg ha^{-1})
	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8			
1	0.56	0.59	0.61	0.6	0.61	0.61	0.62	0.53	4.73	118.10	118.55
2	0.58	0.6	0.6	0.62	0.6	0.6	0.61	0.54	4.75	118.60	
3	0.57	0.61	0.63	0.62	0.62	0.61	0.62	0.51	4.79	119.60	
4	0.56	0.6	0.62	0.6	0.62	0.63	0.61	0.52	4.76	118.85	
5	0.55	0.61	0.61	0.61	0.61	0.61	0.6	0.51	4.71	117.60	

Table.6 Calibration results of tractor drawn aqua planter for groundnut

S. No.	Expected discharge L/min	Obtained discharge (Mean)		Volume of water given in 30 m X 30 m plot (liter)	Application rate, liter/ha
		Tap1	Tap2		
1	60	60.33	60.00	2234.48	24827.58
2	90	89.33	91.00	3351.72	37241.37
3	120	120.0	120.33	4468.96	49655.17

Fig.1 Water tank

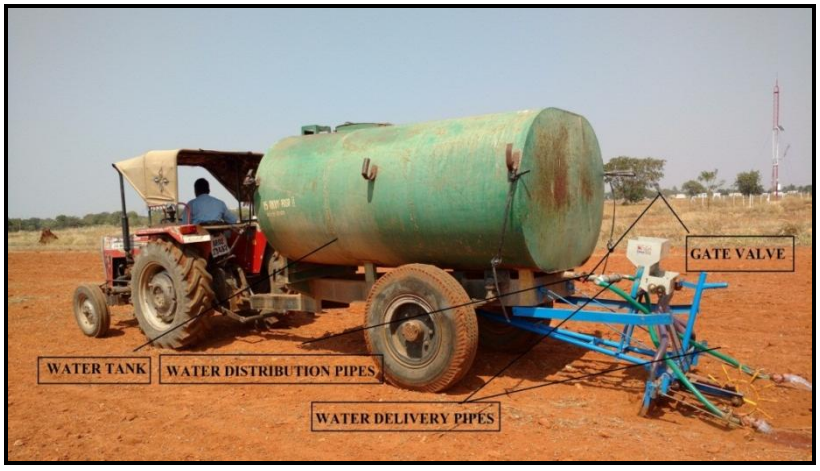

Table.7 Field performance of tractor drawn aqua planter

S. No.	Parameters	Aqua planter for groundnut
1	Plot area, m^2	900
2	Speed of operation, kmph	2.72
3	Effective field capacity, ha h^{-1}	0.145
4	Theoretical field capacity, ha h^{-1}	0.163
5	Field efficiency, %	88.90
6	Plant population, /m^2	22.80
7	Seed rate, kg/ha	105.47
8	Depth of seed placement, mm	51
9	Row to row spacing, mm	228
10.	Seed to seed spacing, mm	100.8
11.	Pod yield, kg/ha	619.38
12.	Cost analysis, Rs/hr	751.42

Seed rates for the groundnut seed observed were 105.47, 108.46, 118.55 kg ha^{-1} respectively for vertical, inclined and horizontal plate metering mechanisms respectively.

The breakage of groundnut seed was found to be less percentage in case of vertical plate metering mechanism. Hence vertical plate metering mechanism was selected for sowing in the field.

The application rate of water in a test plot of 30 m x 30 m was found to be highest for 120 L/min i.e. 49655.17 liters at an average speed of 2.7 kmph groundnut.

The field capacity was found to be 0.145 ha h^{-1} for groundnut with field efficiency of 88.90 per cent at an average speed of 2.72 kmph for aqua planter.

The highest plant population per square meter and plant height in cm for was found to be 22.8 and 21.06 respectively with 120 liters discharge rates.

The highest pod yield obtained for groundnut was found to be 619.38 kg ha^{-1} with discharge rate of 120 L/min whereas the lowest pod yield was found to be 334.15 kg ha^{-1} with discharge rate of 60 L/min.

The cost of sowing operation of aqua planter with tractor for groundnut was Rs. 751.42 per hour.

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