The Andhra Agric. J 59(1): 124-129, 2012

Development and Evaluation of Zero Till Drill for Maize Crop in Andhra Pradesh

Srinivasa Rao Arudra, K V S Rami Reddy, Aum Sarma, B Hari Babu and A Ashok Kumar
College of Agricultural Engineering, Bapatla 522 101

ABSTRACT

During the last 5 years there has been a growing effect by the government to increase the area under maize cultivation, because this crop has ability to thrive under minimal water requirement of 400-600 mm. However, the desired success has not been achieved due to its lower productivity level owing to poor level of mechanization. Preparation of seed bed is the most drudgery involves operation which requires more energy and cost. To reduce the cost involved in preparation of seed bed, to complete the sowing operation in time; a zero till drill has to be developed for maize crop which can sow the maize seed in paddy harvested field without any seed bed preparation. After fabrication and assembly of zero till drill, the field test was carried out. For calculation of cost economics the zero till drill sowing was compared with conventional method of manual dibbling. Effective field capacity of zero till drill was 0.357 ha h^{-1}, efficiency of the zero till drill was 74.3%. Grain yield in zero tillage method was 3416 kg $acre^{-1}$ and manual dibbling method was 3120 kg $acre^{-1}$. There was an increase of 8.66% in yield was observed in zero tillage method over manual dibbling. With zero till drill results in saving of production cost of 21%, saving in time of 75% over conventional method of manual dibbling.

Key words: Grain Yield, Manual dibbling, Seed Bed, Zero Till Drill.

The greatest challenge for India during the 20th century was to enhance agricultural production and productivity to ensure food security for a fast growing population to avert large scale starvation of people .This challenge was duly met by ushering in the green revoluation mid-60's. This was achieved through adoption of biological, chemical and mechanical innovations coupled with right government policies by providing the required instructions, inputs, incentives such as minimum support price to the farmers. Degradation of natural resources is threatening the agricultural produce. Hence during the 21st century balancing food, national and environmental security is going to be the toughest challenge for India. The population is increasing at about 2% per year where as cultivable land is constant or matter of fact reducing. To reach the demand of high population the production has to be increased and more than one crop has to be cultivated in a year in the same field.

Andhra Pradesh farmers are cultivating maize as second crop after paddy. Immediately after harvesting of paddy, tillage is not possible due to high moisture presence in the harvested field. Delay sowing leads to poor yield (Dixit et al.,2004). Traditionally farmers are sowing maize seeds in the paddy harvested field by manual dibbling. Water use efficiency of zero till system is much higher than conventional method (Sarwar et al., 2004).Traditional method of sowing involves more cost, time delay and more energy consumption. To reduce time, energy and cost of seed bed preparation, zero till drill has been specially designed which can sow maize directly after the harvesting of rice without any tillage operation in available field moisture after harvesting paddy.

MATERIAL AND METHODS

Details of the Tractor drawn zero till drill

The whole assembly was mounted on the mild steel frame of 150 cm length and 75 cm in width having square cross section. The metering mechanism used for seed and fertilizer are pick up wheel and fixed hole opening type. Seed metering system is provided with wide range of pick up wheels according to the shape of seeds. In fertilizer box, an agitator is provided at each outlet to avoid bridging. The seed and fertilizer boxes are kept at a height of 85 and 90 cm respectively from the ground. The power for seed and fertilizer metering device is provided from a floating ground drive wheel with the help of chain and sprocket. The ground drive wheel is situated at front of the machine and it is provided with lugs on its periphery for better traction and

Table1. Technical specifications with material of construction of different components of tractor drawn zero till drill

Component	Dimensions (mm)	Material of construction
Furrow opener	60 x 35 x 4	Mild steel sheet
Hopper		
i)Rectangular portion	1100 x 250	18 gauge, Galvanized Iron sheet
ii)Trapezoidal portion		
a)Top	1100 x 250	
b)Bottom	1100 x 120	
Frame	1500 x 750	8 mm thick, Mild steel sheet
Seed metering mechanism	220 Dia,12 cups-10 x 6	Mild steel sheet
Ground wheel	350 Dia,30 lug height	Mild steel sheet

Table.2. Comparison of various sowing parameters between Zero tillage and manual dibbling

S.No	Parameter	Zero Tillage	Manual Dibbling
1	Plant to plant spacing	20.1	18.5
2	Number of seeds per hill	1.0	2.0
3	Plant emergence	8.0	10.0
4	% of missing seeds in m^2	2.5	0.0
5	% of excessive seeds in m^2	7.5	20.0
6	Depth of sowing	35.2	31.0

Table 3. Comparison of various Crop parameters between Zero tillage and Manual Dibbling

S.No	Parameter	Zero Tillage	Manual Dibbling
1	Cob length (cm)	19.66	17.32
2	Cob girth (cm)	17.10	16.70
3	Number of seeds per cob	343.00	293.00
4	Weight of grain per cob (g)	111.10	77.40
5	1000 grain weight (g)	275.90	246.20
6	Grain yield (kg $acre^{-1}$)	3416.00	3120.00
7	Stover yield (kg $acre^{-1}$)	3720.00	3430.00
8	Harvest Index	47.86	47.60

Table 4. Cost of cultivation per acre for maize crop with zero tillage and manual dibbling methods.

S.no	Operation	Zero Tillage		Manual Dibbling	
		Material/labor	Cost(Rs/-)	Material/labor	Cost (Rs/-)
1	Seed bed preparation	——	——	——	——
2	Seed cost	8kg	1600.00	12kg	2400.00
3	Sowing	2.3LD,1.20hrs	400.00	2M+8F	1200.00
4	Thinning	——	0.00	2F	200.00
5	Fertilizer cost	92 kg	1334.00	92 kg	1334.00
6	Fertilizer application-1	——	——	2F	200.00
7	Irrigation-1	9LD	352.53	9LD	352.53
8	Weeding	8F+0.5kg Atragin	972.50	20F	2000.00
9	Fertilizer cost	92 kg	1334.00	92kg	1334.00
10	Fertilizer application-2	2F	200.00	2F	200.00
11	Irrigation-2	9LD	352.53	9LD	352.53
12	Pesticide cost	Endosulphon +Carbofuran 3G	510.00	Endosulphon +Carbofuran 3G	510.00
13	Spraying of pesticide	2M	400.00	2M	400.00
14	Fertilizer cost	92kg	1334.00	92kg	1334.00
15	Fertilizer application-3	2F	200.00	2F	200.00
16	Irrigation-3	9LD	352.53	9LD	352.53
17	Harvesting of cob	8F	800.00	8F	800.00
18	Harvesting of Stover	4F	400.00	4F	400.00
19	Threshing of cobs	30.16q	603.20	27.28q	545.60
Total input cost		**Rs.11146.16**		**Rs.14115.00**	

1litre Diesel (LD) = Rs.39.17
1 Kg seed = Rs. 200.00
1 Female (F) = Rs.100.00
1 Male (M) = Rs.200.00
1 Kg Fertilizer = Rs.14.50
1 liter Endosulphon = Rs.230.00
1 Kg carbofuran 3G =Rs.70.00
1 hour tractor rent = Rs.100.00
1 Kg Atragin = Rs.345.00
1 quintal threshing =Rs.20.00

Table 5. Gross and net income for zero tillage over manual dibbling methods

S. No.	Parameter	Zero till seed cum Fertilizer drill (Rs./Acre)	Manual dibbling (Rs./Acre)
1.	Gross return		
	a) From grain @ Rs. 820/q	28011.20	25584.00
	b) Form stover@ Rs. 1000/acre	1000.00	1000.00
	Total gross income	29011.20	26584.00
2.	Cost of cultivation	11146.16	14115.00
3.	Net income	17865.04	12469.00
4.	Additional income over manual dibbling	5396.04	

Fig1. Zero till Drill in working condition.

undisturbed power transmission to the metering system. Height of lugs is 35 mm and welded parallel to the axis of rotation. Diameter of ground drive wheel is about 350 mm and width is 100 mm. Total weight of the no-till ferti- seed drill is approximately 255 kg. Two supporting wheels each at either side are provided for better support as well as depth adjustment. Specifications of the fabricated zero till drill is given in Table.1.

Manual dibbling

In manual dibbling method maize seeds were sown with the help of dibbler (a wooden stick having sharp edge). For making straight rows a thread was used. The thread was tied to two wooden sticks in each edge of the field. Two persons are required for manual dibbling of each row. One person requires for making holes and another for placing seeds (1 or 2) in the holes and covering. Efficiency of the work was depends on the skill of the labour.

Experimental technique

The field experiment was carried out in manual harvested paddy field. The experimental field area was 2 acres. The field contains two individual plots of each one acre. In the field zero till drill was used to sow maize seed (Fig 1.0) The machine was calibrated in the laboratory at FIM scheme, ARI, Rajendranagar,Hyderabad.The metering mechanism seed rates were adjusted as 8 kg $acre^{-1}$ as per recommendation and recommended dose of fertilizer @ N-48 kg, P_2O_5-16 kg, and K_2O-16 kg per acre. In the second field sowing of maize seed was done with manual dibbling method. Regular observations on plant emergence, height, weed infestation, soil physical properties, crop yield attributes were noted. All the measurements were taken using standard measuring equipment and by adopting standard measurement techniques.

Moisture content

To determine the moisture content, soil samples were taken up to the full depth of core sampler i.e. 115 mm and weighed. The soil samples were kept in an oven for 24 h at 105^0 C. While determining the moisture content of straw, approximately 100 g of straw sample was taken. The 10 samples were kept in an oven for 48 h at 65 °C. After this, weights of the oven dried samples were taken and moisture content (d.b.) was calculated by using the following equation (Tola et al.,2005)

$$MC \frac{w_1 - w_2}{w_2} X\ 100$$

Where, MC = Moisture content % in dry basis

w_1 = Weight of the wet sample (soil or straw), g

w_2 = Weight of the oven dried sample (soil or straw), g

Sowing parameters

Sowing parameters such as plant to plant spacing, number of seeds per hill, plant emergence, missing and excessive hills and depth of sowing were observed while evaluating the zero till drill and the results were compared with manual dibbling method. For every parameter observation five replications were taken.

Fuel consumption

Fuel consumption has direct effect on cost economics of the machine or tillage technique. The fuel consumption was measured using 'Topping Method' (Singh et al., 2009). The fuel tank of the tractor was filled at its full capacity. The tractor along with zero-till drill was run in the test plot at constant speed. After completing the passes, fuel was refilled in the tank up to the original level. The quantity of refilled fuel was measured by measuring cylinder and time required for the completion of sowing.

Effective field capacity

It is the actual area covered per unit of time by a machine. Effective field capacity was determined by using the following relationship:

$$\text{Effective field capacity} \left(\frac{\text{ha}}{\text{h}}\right) = \frac{\text{area covered}}{\text{time taken}}$$

The total time taken in above relationship includes time losses in turning, machine adjustment required during operation.

Field efficiency

Field efficiency is the ratio of effective field capacity and theoretical field capacity. It was determined by the following relationship.

$$\text{Field efficiency} = \frac{\text{Effective field capacity (ha/h)}}{\text{Theoretical field capacity(ha/h)}} \times 100$$

The theoretical field capacity was determined using the following relationship:

$$TFC = WS / 10$$

Where,

TFC = Theoretical field capacity (ha/h)

W = Width of operation (m)

S = Speed of operation (km/h)

Crop parameters

Crop parameters such as cob length, girth, Number of seeds per cob, weight of grains per cob, 1000 grain weight, grain yield, Stover yield and Harvest index were observed while evaluating the zero till drill and the results were compared with manual dibbling method. For every parameter five replications were taken.

Cost economics

We have considered production cost, output cost and net income for calculating the cost economics. Production cost includes the total cost involved in seedbed preparation, sowing, seed, fertilizer, cost involved in irrigation, harvesting and threshing operations. Output cost includes income obtained from grain and stover. The difference between the output cost and the total production cost gave the net income.

RESULTS AND DISCUSSIONS

Moisture content of the soil

Initial moisture content at the time of sowing was observed zero tillage (ZT) method was 22.25% where as 23.66% in manual dibbling (MD) method. After 15 days of sowing first irrigation was given. Moisture contents after 20 DAS were 19.18 % and 19.34 % in ZT and MD respectively. Second and third irrigations were given after 40 days and 65 days. Moisture content at 70 DAS were observed as 22.67% and 22.18 % for ZT and MD respectively. Moisture content at the harvesting time was observed as 13.61% and 12.53 % for ZT and MD respectively.

Sowing parameters

Results of sowing parameters such as plant to plant spacing, number of seeds per hill, plant emergence, missing and excessive hills and depth of sowing were observed while evaluating the zero till drill and the results were shown in table.2

Operational parameters

Fuel consumption and time requirement

Fuel consumption was observed that the fuel consumption of the tractor was 5.02 L ha^{-1}. Total time required to complete sowing of one hectare was calculated by measuring the difference between the initial and final timings of the operations .It was observed that the time required to complete one hectare sowing was 2.80 hours.

Effective field capacity

Effective field capacity of the tractor drawn zero till drill was calculated as 0.357 ha h^{-1}.

Field efficiency

Theoretical field capacity of the machine was 0.48 ha h^{-1} and field efficiency of the machine was 74.37%.

Crop parameters

Results of crop parameters such as cob length, girth, Number of seeds per cob, weight of grains per cob, 1000 grain weight, grain yield, Stover yield and Harvest index were given in table.3.

Cost economics

Total production cost details were given table.4, production cost and net income details were given in Table.5.

Conclusions

The time required to complete one acre of sowing operation was observed as 1.30 hours with zero till drill, where as in case of manual dibbling 60 man-hours have taken. There was considerable saving in time of 75% with zero till drill over conventional method of manual dibbling.

The production cost with zero tillage method was observed as Rs.11146, where as Rs.14115 was observed in manual dibbling. There was saving of 21% of production cost in zero tillage method over conventional method of manual dibbling.

LITERATURE CITED

Dixit J, Gupta R S R, Behl V P and Sukhbir Singh 2004. No-till seed cum fertilizer drill in wheat crop production after paddy harvesting. *Agricultural mechanization in Asia, Africa and Latin America,* 35(1): 19-22.

Mahammad Naeem Sarwar and Muhammad Arif Goheer 2004. Adoption and impact of Zero Tillage Technology for Wheat in Rice-Wheat system – water and cost saving Technology . A case Study from Pakistan.

Singh G P M, Dharambir Dhan and Eno Rai 2009. A case study on: Performance evaluation of zero tillage seed drill in Allahabad district. *Journal of soil and water conservation,* 8(2): 39-43.

Tola E H M and Koeller K 2005. Special distribution of the no-till opener induce seed row incorporated crop residue and soil loosening. *Agricultural mechanization in Asia, Africa and Latin America,* 36(1): 66-70.

(Received on 25.08.2011 and revised on 29.10.2011)