The Pharma Innovation Journal 2022; SP-11(6): 3025-3027

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(6): 3025-3027

www.thepharmajournal.com
Received: 05-03-2022
Accepted: 10-04-2022

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Performance evaluation of electronically automated basin Lister

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Abstract
Basin listing is one of the oldest practice traditionally known as tie ridging or bund forming, it was extensively practiced across India for various crop requirements such as paddy, wheat, onion, millets and vegetable crops. The tractor drawn basin lister on which modification has been made was efficient for the basin formation of 6×2m, but due to its restricted length of bund forming mechanism the automation of the existing implement was taken under consideration for developing the electronically automated tractor drawn basin lister and the performance evaluation was carried out by covering the total area of 1.36 ha for duration 2.23 hr. The functional components of electronic system are Arduino Uno, Relay, Keypad, LCD, I2C, IR sensor and DC motor. The Arduino was programed with Embedded C language in environment IDE 1.18.9.

Keywords: Arduino UNO, tie ridging, moisture conservation, DC motor

Introduction
The current agricultural scenario is upon maximizing water productivity within the land used to feed the growing population of the country. Soil moisture conservation is a key part of increasing water productivity. The conservation of water is particularly important in dry land and rainfed agriculture. To maximize the moisture availability to agricultural crops, in-situ moisture conservation methods must be implemented. Mulching, deep tillage, compartmental bunding, and basin listing are some of the techniques that were used.
The existing implement is a tractor-drawn basin lister, which is a mechanical device with a mainframe, side bund former, lister former, trigger mechanism with power transmission and hitch mast as components. The machine's primary function is to create 6 x 2 m basins that will simultaneously produce side bunds and cross bunds, dividing land into a number of basins. Keeping above facts in view a mechanism that will construct variable-length basins is developed by creating an electronic system that comprises of an Arduino Uno, a DC motor, an IR pulse count sensor, a Relay, an LCD and a keypad. The electronically actuation of system will result into the basins of variable length. In this paper the field performance evaluation of electronically automated basin lister is discussed.

Materials and Methodology
Laboratory test
Soil moisture was determined by oven dry method. It consists of taking a soil sample, determining its exact weight and drying the sample in oven at a temperature of 105 °C to 110° C for 24 h. Then weighing the dried sample and determining the moisture loss by subtracting the oven dry weight from weight of wet sample (IS-2720-part-2, 1973). Bulk density is mass of soil per unit volume was determined with the help of core cutter method.

Field Test
The unit was evaluated for its performance in the field, the test was conducted in medium black soil in the field of Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar. The draft, basin geometry, fuel consumption and wheel slippage were observed during field test.

Basin geometry: The width and height of side bund and cross bund were measured with the help of furrow profile meter and recorded. Distance between two side bunds and cross bunds were measured with the help of 30m long measurement tape.

Draft

The tractor to which the unit was tied had a hydraulic dynamometer mounted to the front of it. The tractor with the attached implement was dragged through the dynamometer using another tractor. The same method was followed by taking out the implement in the same state. The draft requirement to pull implement at the optimised speed is indicated by the difference between the readings.

Fuel consumption

The fuel consumption can be measured by the difference of fuel consumed during field operation and time required to complete operation. The difference in the volume of fuel in the measuring jar before and after the operation gave the volume of fuel consumed

Wheel Slippage

A mark was created on the tractor drive wheel during the field test, and a 30 m distance was marked. The number of revolutions required for the drive wheel to travel the distance under no load and load conditions were measured, for estimation of wheel slippage.

Results and Discussion

Laboratory Test

The average soil moisture content on a dry basis, was found to be 13.36%. The range of soil moisture content for field performance evaluation of automated basin lister was 12 to 14%. The average bulk density of soil was found to be 1.89 g/cc.

Field Test

The electronically automated basin lister was evaluated with 5 field trials covering the total area of 1.36 ha for duration 2.23 hr. The speed ranging from 3.5 to 4 km h^{-1} were kept during field trials. The average speed of operation was observed to be 3.7 km h^{-1}. The average fuel consumption was found to be 8.56 l ha^{-1} and 5.17 l hr^{-1}. The amount of fuel used is influenced by the wheel slip, operation depth and field efficiency. The fuel consumption of automated basin lister varied from 4.81 l h^{-1} at field efficiency of 79.48% to 5.52 l h^{-1} at field efficiency of 78.94%. The draft of an implement is influenced by the forward speed of the operation, the moisture content of the soil and depth of operation. From 298kgf at 3.5 km h^{-1} to 313kgf at 3.8 km h^{-1}, the draft of the implement was observed to be varied.

The average percentage of wheel slippage during the listing operation of tractor operated electronically automated basin lister was observed as 4.57%. The listing operation was carried out at same operating depth throughout the 5 trials hence no major fluctuations in the wheel slippage observed. The average field efficiency was varied from 76.63% to 80.27% based on effective field capacity and theoretical field capacity. Field efficiency is observed to be better as the time required to cover the area is less and time lost in mechanical errors are also less.

Fig 1: Basin of size 8×2 m

Fig 2: Basin of size 10×2 m

Fig 3: Basin of size 4×2 m

Table 1: Summary of field performance carried out for electronically automated basin lister

Sr. No	Parameters	Device program for distance				
		2 m	4 m	6 m	8 m	10 m
1	Location of test	IDE field, MPKV Rahuri, Ahmednagar				
2	Type of soil	Medium Black				
3	Primary tillage before test	Rotavator				
4	Duration of test, hr	0.27	0.30	0.46	0.53	0.67
5	Soil moisture, %	12.36	13.68	13.92	13	13.88
6	Bulk density, g/cc	1.86	1.91	1.67	1.99	2.04
7	Area covered, ha	0.170	0.186	0.291	0.312	0.402
8	Speed of operation km h^{-1}	3.8	3.8	3.5	3.7	3.7
9	Wheel slippage, %	4.36	4.98	4.55	4.39	4.60
10	Effective field capacity, ha h^{-1}	0.62	0.62	0.59	0.59	0.60
11	Theoretical field capacity, ha h^{-1}	0.78	0.79	0.73	0.77	0.76
12	Field efficiency, %	79.48	78.48	80.27	76.63	78.94
13	Draft required, kgf	303	313	298	306	299
14	Average distance between two cross bunds, m	2.7	4.3	6.5	8.4	10.4
15	Average working width, m	2.07	2.08	2.10	2.10	2.06

16	Average height of cross bund, cm	18.38	18.67	18.98	19.01	19.62
17	Average width of cross bund, cm	41.6	41.2	42.06	42.1	42.30
18	Average height of side bund, cm	21.83	21.2	21.44	21.84	21.7
19	Average width of side bund, cm	47.5	48.15	48.1	48.26	48.59
20	Fuel consumption, l ha^{-1}	7.64	8.06	8.9	9	9.20
21	Fuel consumption, l hr^{-1}	4.81	5	5.25	5.31	5.52

Conclusion

The performance evaluation of electronically automated basin lister was carried out at MPKV, Rahuri. The total area covered during the field test by the implement was 1.36 ha for duration 2.23 hr. It was observed that electronically automated basin lister performed well by overcoming the drawback of fixed basin length and the implement was able to form basin of various lengths as per requirements. While in operation no mechanical or electronical error was observed. The field efficiency of electronically automated basin lister was found to be increased greatly and minimum wheel slippage was observed. The working of electronic system is simple, easy to modify and easy to operate, the uploaded programme can be edited or changed according to our requirement.

The draft varied from 298 to 313kgf. The draft of the implement did not vary greatly as the speed was kept almost constant during all trials. Various length of basins i.e., 2.7 m, 4.3 m, 6.5 m, 8.4 m, 10.4 m was formed and dimensions of basins were closed to the required basin length. The average width of basin was observed to be 2.08 m. The average height and width of side bund was observed as 21.60 cm and 48.12 cm. The Average height and width of cross bund or tie ridge was observed as 18.93 cm and 41.85 cm. The average field efficiency of the implement was observed as 78.76% and minimum wheel slippage was observed as 4.57%.

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