Development, Modification and Evaluation of Inter Row Mower for Maize Crop

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Abstract- Crop diversification is need of the hour in Punjab. Maize is seen as an alternative to paddy which can provide nearly equal commercial value to farmer as paddy. Maize is preferably grown on beds and ridges to save water as water requirement of maize is high. Irrigating only the furrows, improves the water application efficiency, even then water requirement of maize remains high. The furrows have to be flooded with water and the major loss of water is through evaporation. The cut/chopped crop covered the top surface of soil for reduced evaporation loss. Modified slant wheels and a stabilizer wheel of machine was stabilized and run in straight in furrows. Field capacity of inter row mower was 0.11 ha/h and fuel consumption of 1.2 l/h at forward. speed of 2.32 km/h. The chopping efficiency, performance index and plant damage were 95.3 to 97.8 percent, 178.99 to 181.81 and 6.09 to 7.05 percent respectively.

Key Words: Chopping efficiency, Inter row mower, Maize, Performance index.

I. INTRODUCTION

Maize is also known as *Zea mays*. India is the major producer of maize in the world. The area in the country is 9.08 million hectares with production of 23.28 million tones and productivity of 2563 kg ha^{-1}[1]. India is basically dependent on rain fed agriculture. India has about 47 million hectares of dry lands out of 108 million hectares of total rain fed area. Dry lands contribute more than 40 per cent food grains, 80 per cent of maize, 95 per cent of pearl millet and sorghum. Thus, dry lands and rain fed farming will continue to play a dominant role in agricultural production [4].

Due to the rapid population growth and economic development, a growing of regions has been facing increasingly severe water scarcity. The shortage of water resources will lead to the constraint on food production. Ground water level is decreasing at a drastic rate. There is a fall of about 7 to 11 m in ground water level in last 45 years in the Indo-Gangetic Plains i.e. a decline of around 0.22 m of water table every year.

Maize is preferably grown on beds and ridges to save water as water requirement of maize is high. Irrigating only the furrows, improves the water application efficiency, even then water requirement of maize remains high. The furrows have to be flooded with water and the major loss of water is through evaporation. The evaporation losses can be reduced if the water surface is covered with some crop [3]. Chopping/ cutting of inter rows of maize grown furrows acting as mulch will reduce water requirement of main crop grown on beds. Microbial decomposition decreases, in the mulched area, as the soil temperature decreases [2]. This has significant effect on the yield, soil productivity besides moisture conservation. Therefore attempt is being made to evaluate the performance of inter row mower, developed to cut rows of maize grown in furrow.

II. EXPERIMENTAL DETAILS

The inter row mower was evaluated at Research Farm of Department of Farm Machinery and Power Engineering, Punjab Agricultural University (P.A.U), Ludhiana. Sowing of maize variety PMH1 was done in spring season. The beds were made by tractor operated raised bed and sowing was done manually. The main maize crop was planted in the middle of the bed and two rows of crop planted at the edge of the bed and one row in the middle of furrow of two beds (Fig. 1). The row to row spacing of main crop was 675 mm, plant to plant spacing was 150 mm and depth 50-80 mm. Seed rate was (25x4)100 kg/ha, the seed was treated by Gaucho herbicide before sowing. Fertilizers namely Urea and SSP also applied as per package of practices of Rabi crop. The chopping of maize crop was done 35 days after sowing (DAS) of crop. The self-propelled inter row mover was operated between two beds to chop the crop grown in middle of furrow and edges of the bed. The main crop remained as it is on middle of bed.

Performance evaluation of inter row maize mower:

Self propelled inter row mower was evaluate with different parameters, chopping efficiency, performance index, field capacity, speed of operation, fuel consumption and plant damage were evaluated and described by [5]

Chopping Efficiency:

$$CE\ (\%) = \frac{W_1 - W_2}{W_1}$$

Where,

W_1 = Number of crop before chopping

W_2 = Number of crop after chopping

Plant Damage:

$$\text{Plant damage (\%)} = \frac{Q_2}{Q_1} \text{ x } 100$$

Where,

Q_1 = Number of plants in 10 m row length before chopping

Q_2 = Number of plants damaged along 10 m row length after chopping

Performance index (PI):

$$PI = \frac{FC\ \left(\frac{ha}{h}\right) x\ ((100 - PD\ (\%)) x\ CE\ (\%)}{Power\ (hp)}$$

Where,

FC = Field Capacity, (ha/h)

PD = Plant Damage, (%)

CE = Chopping Efficiency, (%)

Field capacity:

$$FC = \frac{Working\ width\ of\ machine\ (m)\ x\ Speed\ of\ operation\ \left(\frac{km}{h}\right)}{10\ x\ 100}$$

x Field efficiency(%)

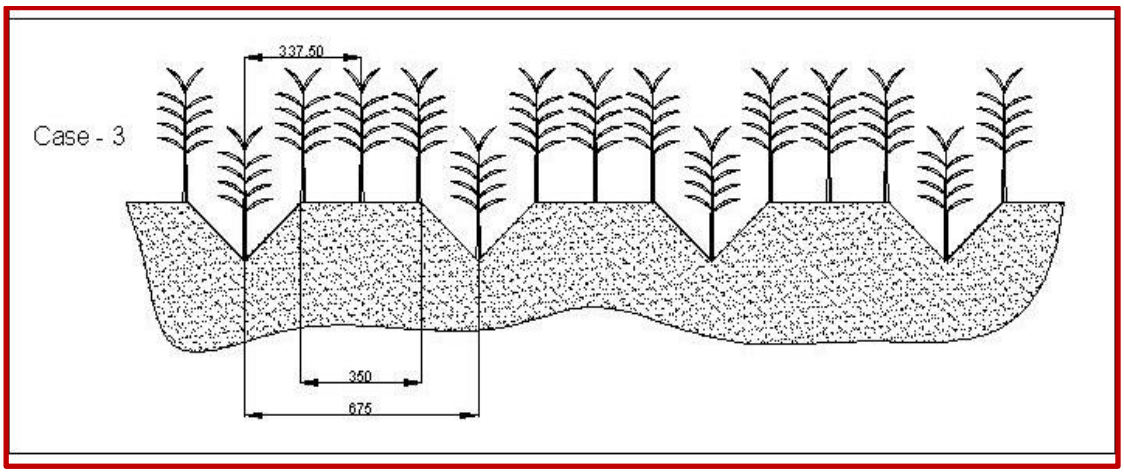

Fig. 1. Schematic view of maize sowing for chopping by inter row mower

III. PRE – EXISTING MACHINE

Inter row rotary mower consisted of self-propelled mower having 455 mm reciprocating type serrated knife cutter bar, a diesel engine of 4.1kW, three forward gears and one reverse gear, handles with attachment of PTO, gear clutch and two pneumatic wheels as shown in Fig. 2. The machine does not work as such in the furrows. This machine does not work effectively in the crop grown on beds. It was difficult to operate the machine due to the disturbed bed geometry. The main crop was damaged by the cutter in cases of reduced distance between the mulch crop and main crop.

Fig. 2. A view of pneumatic wheel type inter row mower

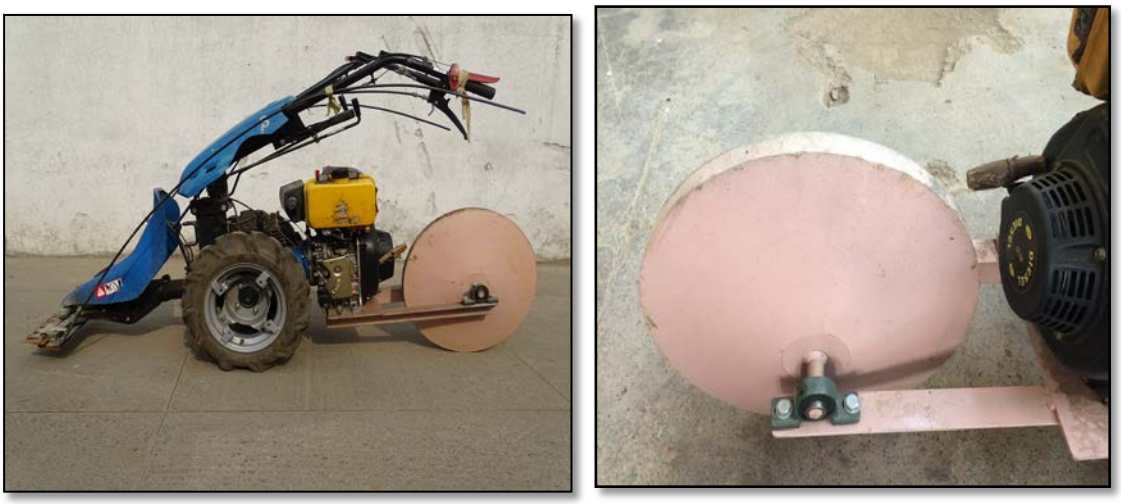

Fig. 3 Inter row mower with pneumatic wheel and a stabiliser

IV. FIRST PROTOTYPE

In this developed design the self propelled mower has pneumatic wheels and stabilizer wheel was mounted at the rear of the mower. The surface of stabilizing wheel has to be mirror image of furrows of beds as shown in Fig. 3. This prototype does not work well because the distance between main crop and the mulched crop was reduced as change in bed geometry, due to which the main crop was damaged while chopping.

V. SECOND PROTOTYPE

A self-propelled mower has been modified to work in the crop grown on beds. The first prototype was equipped with pneumatic wheels which were replaced with steel wheels having slant of 45^{o}. Small steel trips were provided on the surface of slant surface that act as lugs. Two metallic slant wheels, a stabilizer and two crop deflectors were provided as shown in Fig. 4. To ensure proper chopping and mulching of crop grown in furrows, without breaking of beds, the wheels of the machines were modified. Two wire crop dividers were also be required at the ends of cutter bar to deflect the leaves of middle row away from cutter bar.

These crop dividers were made from steel strip. Their surface was slant and lugs were welded on these to provide stability to the machine while moving in a straight line on inclined path. Because of the heavy tapered wheel the contact surface area of the wheels with the bed sides was more than pneumatic wheels, so the grip between the wheel and the soil increased, resulted in better movement of the mower. The movement of inter row cutter was also assisted by stabilising roller. At the front end of the machine there was a reciprocating cutter bar to cut the crop. Crop dividers/ guides have been provided to restrain the main crop getting cut. There are levers to stop the movement of either machine or cutter bar or both.

Fig. 4 Inter row mower with two slant and a stabilizer wheel

Fig. 5 a) Maize crop before operation b) Maize crop after operation

Table 1: Performance evaluation of inter row mower on maize crop

S. No.	Parameters	Observation
1.	Working width, mm	455
2.	Working speed, km/h	2.32
3.	Field capacity, ha/h	0.11
4.	Fuel consumption, l/h	1.2
5.	Field efficiency, %	73.92
6.	Plant damage, %	6.09- 7.05
7.	Chopping efficiency, %	95.3-97.8
8.	Performance index	178.99-181.81

The Table 1 shows the performance evaluation of inter row mower on maize crop the field capacity was observed 0.11 ha/h and speed of operation was 2.32 km/h. The field efficiency and fuel consumption were observed 73.92% and 1.21 l/h respectively. The plant damage was 6.09 to 7.05 percent. The performance index of inter row cutter was raged from 178.99 to 181.81. The cut/chopped crop covered the top surface of soil for reduced evaporation loss hence conserving soil moisture, reduced weed growth, improving soil temperature and also improved soil fertility and modified micro-environment of soil to meet the needs of plants for better plant growth.

VI. CONCLUSION

Modified slant tapered metallic wheel helped in stabilizing the movement of inter-row mower. Inter-row maize mower could cut the maize plant taller than 200 mm in furrows. The inter row maize cutter was sufficient at plant taller than 200 mm in furrows. The field capacity and chopping efficiency 0.11 ha/h and 73.92 percent respectively. The performance index was 178.99 to 181.81. The losses of main maize crop during chopping operation varied from 6.09 to 7.05%. The chopped crop covered the surface and reduced the evaporation loss.

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