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Performance of Mini-Tractor Operated Inclined Plate Maize Ridge Planter

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ABSTRACT

A mini-tractor drawn maize ridge planter was developed and its performance was evaluated for planting of maize with inclined plate metering mechanism. This planter was tested at three speeds, 2, 2.5 and 3 km h^{-1}. Effective field capacities of the planter were 0.16, 0.212 and 0.251 ha h^{-1}, respectively. Ground wheel slip was 2.45, 1.04, and 0.90%, respectively. The fuel consumption of tractor for planting of maize was 2.07, 2.43 and 2.72 L h^{-1}, respectively. Seed miss index was less at 2.5 km h^{-1} speed of operation with the inclined plate metering mechanism. The spacing between seed to seed for planter with inclined plate metering mechanism was 19.23, 20.02 and 22.40 cm at 2, 2.5 and 3 km h^{-1} speed of operations, respectively. The average depth of planting for ridge planter was 41.67 mm. Plant population in one square meter for planter was 12, 10 and 8 at 2, 2.5 and 3 km h^{-1} speed of operations, respectively.

Keywords: *Maize planter, Seed to seed distance.*

Maize (*Zea mays* L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as "Queen of cereals" because it has the highest genetic yield potential among the cereals and also staple food for human being and quality feed for animals. Among the cereal crops in India, Maize with annual production of around 22.5 million tonnes from 8.67 million hectares ranks third in production and contributes to 2.4% of world production with almost 5% share in world harvested area (Gracy *et al.*, 2013). It is the third most important cereal crop in both the world and India, after rice and wheat. It is cultivated on nearly 179.72 m ha (2014-15) in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (1014.37 million metric tonnes) in the global grain production. The USA has the highest productivity (>10.73 metric tonnes ha^{-1}) which is double than the global average (5.64 metric tonnes ha^{-1}). Whereas, the average productivity in India is 2.63 metric tonnes ha^{-1} and India share in global export of maize is 14% (2014-2015) (USDA, 2016).

In India maize consumption has increased at a Compound annual growth rate (CAGR) of 3.6% over the last five years and poultry feed accounts for 50% of maize consumption. According to advance estimate its production is 15.5 million tonnes (2015-16) mainly during Kharif season which covers 80% area. Production of maize in India is dominated by Andhra Pradesh and Karnataka which contributes to 38% of total production. In India, the maize is used as human food (23%), poultry feed (51%), animal feed (12%), industrial (starch) products (12%), beverages and seed (1% each). Dry land contributes 42% of the total food grain production of the country. These areas produce 90% pulses, 80% oil seeds, 65% cotton and 87% of coarse cereals further support 40% humans and 60% livestock population. World population is increasing day by day which is a serious threat to food security. This can be overcome by enhancing production of major crops like maize. So the demand for maize is increasing day by day in the world as well as India. But the maize yield varied greatly in different countries. The factors affecting maize yield are conventional method of cultivation and also lack of precision planting technologies. The lack of agricultural labour lead to increase in production cost, therefore mechanization represents an important factor to reduce the costs and increase the productivity (Hobbs, 2003).

The method of planting also plays a vital role for better establishment of crop under a set of growing situations. The sowing of the crop is the placement of seed in the soil at the proper depth with proper moisture and soil temperature. Among the various agronomic practices planting technique is of considerable importance because of optimum plant population and also proper use of the land and input resources (Ali *et al.,* 1998). It has been reported that planters provide desired plant population with uniform plant spacing and depth of operation, which results in uniform crop stand and hence, reduced cost of cultivation is achieved due to elimination of thinning operation as well as sowings of seed and fertilizer (Pandey, 2009). Many researchers studied the performance of different maize genotypes under different planting methods and concluded that maize planted on ridges and raised beds performed well regarding growth and final yield of maize (Bakht *et al.,* 2006; Abdullah *et al.,* 2008; Bakht *et al.,* 2011). Klenin *et al.,* (1985) observed that planting on ridges improves the drainage which is essential in regions with high soil moisture and in irrigated region.

At present, large farmers alone are using tractor operated machinery and implements because of high initial cost involved in the purchase of present tractors. The medium horse power tractors ranging from 31 - 40 hp are most popular and are fastest growing segment. The cost of these tractors is as high as 5.0 - 6.75 lakhs, which is beyond the purchasing capacity of small and marginal farmers. Hence there is a need to introduce low horse power tractors with suitable matching equipment's to improve the Socio- economic condition of farming community. Considering these new tendencies of planting for maize crop production, a ridge planter for sowing maize was developed. The objective of this study was to evaluate the performance of mini tractor drawn inclined plate maize ridge planter.

MATERIALS AND METHODS

The performance of developed maize ridge planter was evaluated with different forward speed of operation (2, 2.5 and 3 kmph). The field trial of mini tractor drawn maize ridge planter was conducted in the field of Regional Agricultural Research Station, Nandyal. The size of plot selected for trial was 50 m × 6 m the row to row spacing was kept 60 cm. The variety of maize PRATAP-609 was used for field trial. The performance of mini-tractor drawn ridge planter was evaluated in terms of following:

Field capacity

Field capacity is defined as the rate of field coverage by the planter. Turning time at the end of the field was added with actual operating time for effective field capacity determination.

Theoretical and effective field capacity of the planter was determined by the following two equations (Raghavendra *et al.,* 2013).

a) Theoretical field capacity

$$C_{th} = \frac{S \times W}{10}$$

where

C_{th} = Theoretical field capacity, ha h^{-1}

S = Forward speed, km h^{-1}

W = Width of coverage, m

b) Effective field capacity

$$C_{eff} = \frac{A}{T}$$

where

C_{eff} = Effective field capacity, ha h^{-1}

A = Field coverage, ha

T = Actual time of operation, h

Field efficiency

Field efficiency is the ratio of effective field capacity to the theoretical field capacity. It was calculated using the following formula:

$$F_e = \frac{C_{eff}}{C_{th}} \times 100$$

where F_e = Field efficiency, %

Fuel consumption

Fuel tank was filled to full capacity before and after each test trial. The volume of fuel refilled after the test is the fuel consumption during the test. When filling up the tank, careful attention has taken to keep the tank horizontal and not to leave empty space in the tank.

$$F_t = \frac{V}{t}$$

where

F_t = Fuel consumption rate, L h^{-1}

V = Volume of fuel consumed, L

t = Total operating time, h

Ground wheel slip

It was calculated by recording actual number of revolutions of ground wheel for given distance (Thakare *et al.,* 2014).

$$\text{Ground wheel slip (\%)} = \frac{N_t - N_a}{N_t} \times 100$$

$$N = \frac{L}{\pi D} = \frac{\text{Distance to be travelled}}{\text{Circumference of wheel}}$$

where

N_t = Theoretical number of revolutions made by ground wheel for given distance.

N_a = Actual number of revolutions made by ground wheel for given distance.

Seed to seed spacing

Seed to seed spacing maintained by the planter was measured very carefully. The seed to seed spacing was measured after 10 days of sowing with a scale. After observation, the average seed spacing was calculated.

Depth of sowing

Depth of sowing is an important factor on which the germination and yield of the crop depends. The depth of sowing was calculated by removing the top soil without disturbing the position of seed and depth was measured using meter rule. For this 10 random observations were taken and average was calculated (Dhok *et al.,* 2015).

Plant population per square meter

The number of plants per square meter was counted using a square metallic frame. The plant population was averaged from the 3 random points after 10 days of sowing in the field.

Miss index

The missing percentage is represented by an index called the miss index (MI) which is the percentage of spacing's greater than 1.5 times the set spacing (X). It was calculated after germination by using the following formula (Katchman and Smith 1995).

$$I_{miss} = \frac{n_1}{N}$$

where

n_1 = Number of spacing > 1.5 X
N = Total number of spacing measured

Multiple index

The multiple, more than one seed, percentage is represented by an index called Multiple Index (I_{mult}) which is the percentage of spacing's that are less than or equal to half of the set spacing (X). It was calculated after germination by using the following formula (Katchman and Smith 1995).

$$I_{mult} = \frac{n_2}{N}$$

where

n_2 = Number of spacing d" 0.5 X
N = Total number of spacing measured

Quality of feed index

The quality of feed index is an alternate way to present the performance as a result of combined effect of misses and multiples. The quality of feed index (A) is the percentage of spacing's that are more than half but not more than 1.5 times the set spacing.

Quality of feed index = 100 – (miss index + multiple index)

RESULTS AND DISCUSSIONS

Field capacity of the planter

The theoretical field capacity of the mini tractor drawn maize ridge planter was calculated as 0.24, 0.3 and 0.36 ha h^{-1} at 2, 2.5 and 3 km h^{-1} forward speed of operation.

The effective field capacity of the planter was calculated by measuring the time taken to cover the given area and is presented in Table 1 at 2, 2.5 and 3 km h^{-1} forward speed of operation.

Table 1: Effective field capacity of the planter

S. No	Speed (km h^{-1})	Total area covered (m^2)	Time taken to cover area (s)	Effective field capacity (ha h^{-1})
1.	2.0	300	675	0.160
2.	2.5	300	510	0.212
3.	3.0	300	430	0.251

The field capacity of the mini tractor drawn maize ridge planter was found to be 0.16, 0.212 and 0.251 ha h^{-1} at forward speed of 2, 2.5 and 3 km h^{-1}, respectively.

Field efficiency of the planter

Field efficiency is the ratio of effective field capacity to the theoretical field capacity. The test result of field efficiency of the planter is shown in Figure 1.

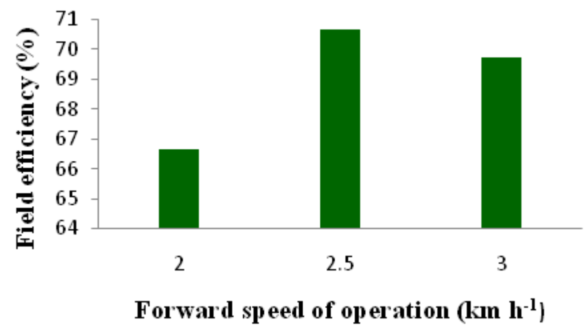

Figure 1. Field efficiency of the planter at different forward speed of operations

The field efficiency of the mini tractor drawn maize ridge planter was found to be 66.67, 70.67 and 69.72% at forward speed of 2, 2.5 and 3 km h^{-1}, respectively. From the Figure 1 it is evident that the field efficiency of the planter was slightly more at the forward speed of 2.5 km h^{-1}. And it is in the range between 65 – 75 percent.

Ground wheel slip

Ground wheel is the main drive for the metering mechanism for drop the seed properly. Ground wheel slip indicates accuracy of seed drop. The test results of ground wheel slip is shown in Figure 2.

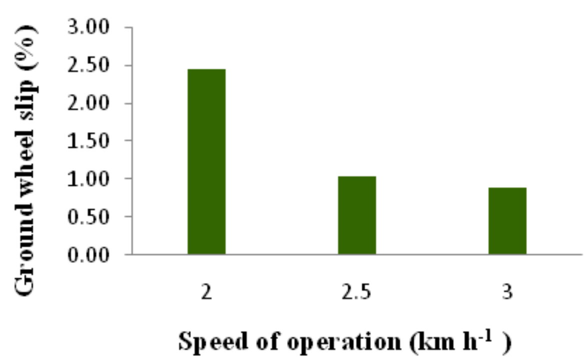

Figure 2. Ground wheel slip while planting at different forward speed of operations

The ground wheel slip of the mini tractor drawn ridge planter was found to be 2.45, 1.04 and 0.9 per cent at forward speed of 2, 2.5 and 3 km h^{-1}, respectively. From the Figure 2 it is evident that the ground wheel slip is decreased with increase in forward speed of operation. Similar results were reported by Veerangouda and Shridhar (2010).

Fuel consumption

Fuel consumption of the mini tractor drawn maize ridge planter was found to be 2.07, 2.43 and 2.72 L h^{-1} at forward speed of 2, 2.5 and 3 km h^{-1}, respectively. The data of results pertaining to the measurement of fuel consumption is shown in Figure 3.

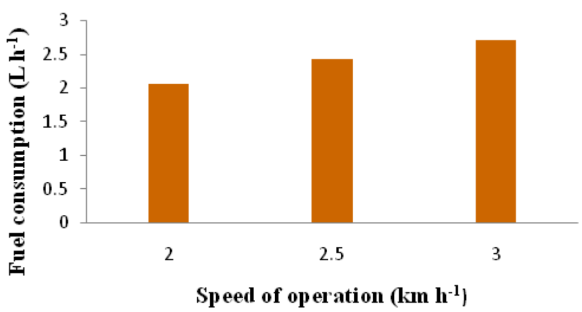

Figure 3. Fuel consumption of the planter

It was observed that the fuel consumption of the planter was increased with increase in speed of operation because if the speed increases then draft will increase so consumption of the fuel is increased with increase of speed.

Seed to seed spacing achieved

Seed to seed spacing of maize crop was observed in the field at different planting speeds with inclined plate metering mechanism, after 10 days of sowing. The average seed to seed spacing for different speed of operation were presented in Table 2.

Table 2: Seed to seed spacing of the planter at different speeds and at different metering mechanisms

Speed (km h^{-1})	Average Seed spacing (cm)
2.0	19.23
2.5	20.02
3.0	22.4

From the Table 2 it is evident that the seed to seed distance of the maize was increasing with increased speed of operation. But the required spacing (around 20 cm) was occurred at 2.5 km h^{-1} forward speed of operation.

Missing, multiple and quality index

Misses created when seed dropping, cell fail to drop seed to the opening. The average missing index, multiple index and quality of feed index for different speed of operation was presented in Table 3.

Table 3: Missing, multiple and Quality of feed index of the planter

Speed (km h^{-1})	Average missing index (%)	Average multiple index (%)	Average quality feed index (%)
2.0	1.28	3.84	94.87
2.5	6.73	4.06	89.21
3.0	8.96	0.0	91.04

From the Table 3 it is evident that the missing index of the planter was increases with increase in speed of operation. The highest missing index was at 3 km h^{-1} speed of operation.

Plant Population

The average plant population in one square meter for different speed of operation was presented in Table 4.

Table 4: Plant population per 1 m^2 area

Speed (km h^{-1})	No. of Plants per 1 m^2 area
2.0	12
2.5	10
3.0	8

From the Table 4 it is evident that the plant population of the maize per one square meter area was decreased with increase in speed of operation because if the speed of operation increases then spacing increases so the plants per square meter area also decreases.

CONCLUSION

Effective field capacities of the developed ridge planter at 2, 2.5 and 3 km h^{-1} speed of operations were 0.16, 0.212 and 0.251 ha h^{-1}, respectively. Ground wheel slip of the developed ridge planter at 2, 2.5 and 3 km h^{-1} speed of operations was 2.45, 1.04, and 0.90 per cent, respectively. The fuel consumption of tractor for planting of maize at 2, 2.5 and 3 km h^{-1} speed of operations were 2.07, 2.43 and 2.72 l h^{-1}, respectively. Seed miss index was less at 2.5 km h^{-1} speed of operation with the inclined plate metering mechanism. The spacing between seed to seed for planter with inclined plate metering mechanism was 19.23, 20.02 and 22.40 cm at 2, 2.5 and 3 km h^{-1} speed of operations, respectively. Plant population in one square meter for planter with inclined plate metering mechanism was 12, 10 and 8 at 2, 2.5 and 3 km h^{-1} speed of operations, respectively.

LITERATURE CITED

Abdullah G H, Khan I A, Khan S A and Ali H 2008 Impact of planting methods and herbicides on weed biomass and some agronomic traits of maize. *Pakistan Journal of Weed Science Research.* 14: 121-130.

Ali M, Khalil S K, Ayaz S and Marwat M I 1998 Phenological stages, flag leafarea, plant height, and leaves perplant of corn influenced byphosphorus levels and plantspacing. *Sarhad Journal of Agriculture.* 14: 515-522.

Bakht J, Ahmad S, Tariq M, Akber H and Shafi M 2006 Response of maize to planting methods and nitrogen fertilizer. *Journal of Agricultural and Biological Sciences*.1: 8-14.

Bakht J, Shafi M, Rehman H, Uddin R and Anwar S 2011 Effect of planting methods on growth, phenology and yield of maize varieties. *Pakistan Journal of Botany.* 43: 1629-1633.

Dhok A S, Biwal V D, Ghadge S B and Sutkar P D 2015 Performance evaluation of bullock drawn planter with low cost metering device. *International Journal of Agricultural Engineering.* 8(1): 136-139.

Gracy C P, Jyoti N and Nagashree N 2013 Maize prices to hover around MSP. *Department of Agricultural marketing cooperation and business Management, UAS, GKVK, Bangalore.*

Hobbs R P 2003 Reduced and zero-tillage options.In:Addressing Resource Conservation Issues in Rice-Wheat Systems of Sough Asia: A Resource Book. *Rice-Wheat Consortium for theIndo-Gangetic Plains – International Maize and Wheat Improvement centre, New Delhi.* 109-112.

Klenin N I, Popov I F and Sakun V A 1985 Agricultural machines. *Amerind Pub. Co. Pvt. Ltd., New Delhi.*125-140.

Katchman S D and Smith J A 1995 Alternative measures of accuracy in plant spacing for planters using single seed metering. *Trans. ASAE.* 38(2): 379–387.

Pandey M M 2009 Country Report India -Indian Agriculture an Introduction. *Central Institute of Agricultural Engineering Bhopal, India.Presented in Fourth Session of the Technical Committee of APCAEM 10-12 February 2009,Chiang Rai, Thailand.*

Raghavendra, Veerangouda M, Prakash K V, Vijaykumar P, Sharankumar H and Devanand M 2013 *Karnataka Journal of Agricultural Science.* 26(1): 88-91.

Thakare S H, Kadam D M and Saraf V V 2014 Performance evaluation of bullock drawn cotton planter. *International Journal of Agricultural Engineering.* 7(2): 442-445.

USDA 2016 World Agricultural Production, Circular Series WAP 10-16.

Veerangouda M and Shridhar B 2010 Effect of planter forward speed and depth of operation on draft and ground wheel slip. *Karnataka Journal of Agricultural Science.* 23(4): 665.

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