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Response of Maize (*Zea mays L*) Crop to Different Planting Machine: A Review

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Abstract- Availability of a multi crop planter with replaceable metering plate is crucial to meet the seed rate requirements and to reduce the cost involved in machinery management. Though different types of planters having different seed metering mechanisms were evolved, their performance is not up to the mark. Seed metering device is a heart of seed sowing machine which is evaluated for seed distance, seed size between seed varieties. In India traditionally sowing of maize with help of animal and manual operated planter which is very tedious and slow process. The study of existing literature of maize planter shows there are mainly three types of planter viz. manually operated planter, animal drawn planter and tractor operated planter with raised bed planting and flat planting. Performance of available planter on different parameter has been studied which shows tractor operated planter gives better result. Study also focus on their limitations of cost and source of power supply. There is scope of seed metering mechanism on developed tractor drawn planter which will changeable by other crop of metering plate. By attaching different types of metering plate we can use multicrop planter for sowing of different crops.

Keywords – Maize, Tractor drawn planter, Animal drawn planter, Manual operated planter, Raised bed planting, Flat planting, Cost economic.

INTRODUCTION

In India, maize is the third most important food crops after rice and wheat. According to advance estimate it is cultivated in 8.7 million ha (2010-11) mainly during *Kharif* season which covers 80% area. Maize in India, contributes nearly 9% in the national food basket and more than Rs. 100 billion to the agricultural GDP at current prices apart from the generating employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc.

Maize is mainly sown directly through seed by using different methods of tillage and establishment but during winters where fields are not remain vacant in time (till November), transplanting can be done successfully by raising the nursery. However, the sowing method (establishment) mainly depends on several factors *viz* the complex interaction over time of seeding, soil, climate, biotic, machinery and management season, cropping system, etc. Therefore it is very important that different situations require different sowing methods for achieving higher yield. Sowing/planting should be done on the southern side of the east-west ridges/beds, which helps in good germination. Planting should be done at proper spacing.

REVIEW OF LITERATURE

A prototype punch planter was developed for no-till corn to provide different seed spacing. Plant population was adjusted by changing planter punch wheels. Seed spacing of 136, 165, and 210 mm were obtained by constructing three punch wheels with different punch lengths, represented by external diameters of 650, 825, and 1,000 mm, respectively. Laboratory and field tests were conducted at speeds of 1.5, 2.0, and 2.5 $m \cdot s^{-1}$ to evaluate the effect of the punch lengths and speeds. Field tests were conducted in three different residue covers (corn, grain sorghum, and soybean). Overall, high values for quality of feed index (spaces between seeds or plants within 0.5 and 1.5 the theoretical seed spacing) were observed. Despite problems with synchronization between the seed meter and punch wheels, the length of the punches offered no performance limitations at the speeds tested. A soil cleaning device was designed to reduce soil sticking to the punches and reduce soil disturbance. The volume of soil displaced by the smallest punch wheel (650 mm) was less than half of that displaced by a commercial notill planter. Differences in planting depth due to residue cover and punch wheel

diameter were minimal. Emergence was delayed under the corn residue cover and may have influenced the lower performance of the planter prototype as compared to the other two residue types (Molin *et al*., 1998).

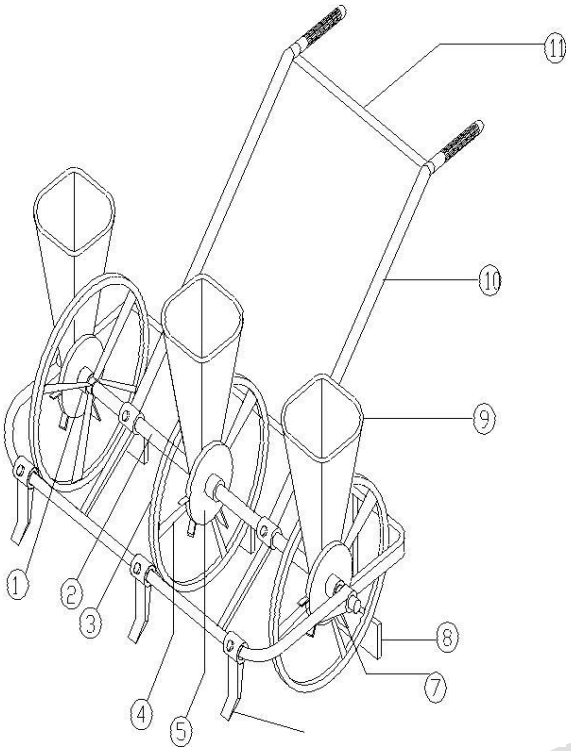
No-tillage and raised beds are widely used for different crops in developed countries. A field experiment was conducted on an irrigated maize-wheat system to study the effect of field layout, tillage and straw mulch on crop performance, water use efficiency and economics for five years (2003–2008) in northwest India. Straw mulch reduced the maximum soil temperature at seed depth by about 3ºC compared to the no mulch. During the wheat emergence, raised beds recorded 1.3ºC higher soil temperature compared to the flat treatments. Both maize and wheat yields were similar under different treatments during all the years. Maize and wheat planted on raised beds recorded about 7.8% and 22.7% higher water use efficiency than under flat layout, respectively. Straw mulch showed no effect on water use and water use efficiency in maize. The net returns from the maize-wheat system were more in no tillage and permanent raised beds than with conventional tillage. Bulk density and cumulative infiltration were more in no tillage compared with conventional tillage (Ram *et al*., 2011).

Inclined plate seed metering device was designed and evaluated in laboratory for singulation and uniform placement of maize and soybean seeds at three different cell shapes and sizes. The performance parameters like average spacing, multiple index, quality of feed index and precision were measured. Among the combinations of design variables, the seed metering plate with semi-circular cell shape having cell size 7 mm diameter was found to be the optimum for metering maize seed. Average spacing, quality of feed index, multiple index, miss index and precision were 17.48 cm, 79.33%, 18.67%, 2% and 10.5%, respectively (Singh *et al*., 2014).

A three - row bullock drawn multi-crop inclined plate planter was developed at C.I.A.E Bhopal for sowing different type of crops. The calibration for the seed and fertilizer rate was done in the laboratory of C.A.E. , R.A.U., Pusa, Samastipur. The seed rate was found 20.60 kg·ha^{-1} for the maize crop and fertilizer rate was found from 9.3 kg·ha^{-1} to 124.3 kg·ha^{-1}. The wheel skid was in tolerable limit as it was recorded 4.53 %. The field capacity was 0.23 ha·hr^{-1} and field efficiency was 51.1%. The plant population was found 10-12 plants per square meter. The cost of sowing per hectare was 3.5 times economical than traditional method (Nirala *et al.*, 2011).

Seed metering devices meter the seed from the seed box and deposit it into the delivery system that conveys the seed for placement on or in the seedbed. The major functional requirements of seed metering systems are to meter the seed at a predetermined rate/output (e.g. kg·ha-1 or seeds/meter of row length) meter the seed with the required accuracy (spacing) to meet the planting pattern requirements (i.e. drill seeding, precision drilling, etc); and cause minimal damage to the seed during the metering process. The seed sowing machine is a key component of agriculture field. The performance of seed sowing device has a remarkable influence on the cost and yield of agriculture products. Therefore studied the review on the field performance of three different types of planter (manual operated, animal drawn and tractor drawn) for sowing of maize crop.

Oduma et al., (2014) evaluated the performance of developed three-row manually operated maize seeding machine. An average weight varying from 4.44g to 4.72g of seeds was discharged by the three hoppers at a mean planting space range of 48.2cm to 49.8cm obtained from the field and laboratory test respectively. The planter effectively metered out two seeds per discharge at average planting depth varying from 2.47cm to 2.60cm with minimum percentage seed damage of 1.79%. The field efficiency of 72.3% and average field capacity of 0.43 ha/hr were obtained from the test. The planter is simple to operate portable and easy to maintain and can relief the difficulties encountered by maize farmers in rural areas if properly maintained.



DESCRIPTION
1. Bushing
2. Axle
3. Drive/transport wheel
4. Stroke
5. Metering disc
6. Furrow opener
7. Discharge tube
8. Furrow covering device
9. Hopper
10. Handle
11. Cross bar (support for handle)

Figure 1: Three-Row maize planter

Narang et al., (2015) evaluated the 3 planters namely tractor operated raised bed planter, inclined plate planter and manually operated multicrop planter in field for sowing of maize. The mean grain yield per ha was found maximum for raised bed maize planter as 7.017 t-ha^{-1} and for inclined plate planter and manually operated planter it was 5.778 t-ha^{-1} and 6.097 t-ha^{-1}, respectively. The percent saving in labor cost and time in maize sown with raised bed planter was 89.90% and 91.80% as compare to maize sown with traditional manual method and was highest among three planters. Planting of maize was done with the machines viz. raised bed (ridge) planting as well as inclined plate planter and manual planter at the departmental research farm in sandy loam soil. The three machines were operated in the field and parameters like width, forward speed, depth of seed placement and fuel consumption were measured and are shown in Tab. 2. It is clear from Tab. 1 that average fuel consumption for raised bed planter was 4.95 l·hr-1 whereas for inclined plate planter it was 6.03 l·hr^{-1}. The average field capacity of raised bed planter was 0.49 ha·h^{-1}, for inclined plate planter was 0.48 ha·h^{-1}, whereas for manually operated planter it was 0.23 ha·h^{-1}, and the effect of different machines was significant on field capacity, as well as on forward speed at 5% level of significance. The depth of seed placement varied from 20-50 mm for three planters and the effect of different their effect on depth of seed placement was nonsignificant at 5% level of significance.

Table 1. Field parameters for three different planters

Name of machine	Raised bed planter	Tractor drawn inclined plate planter	Manually operated planter	CD at 5 %
Width of machine (m)	1.80	1.80	0.04	
Mean forward speed (km·h^{-1})	2.72	2.68	0.48	0.151757
Mean effective field capacity (ha·h^{-1})	0.49	0.48	0.23	0.0256957
Mean depth of seed placement (mm)	40.00	33.33	23.33	NS
Mean fuel consumption (l·h^{-1})	4.95	6.03	--	--

Fig.2 Raised bed maize multicrop planter

Fig.3 Inclined plate planter

Fig.4 Manually operated planter

Table 2. Economics analysis of different planters used for sowing of maize

Method of planting	Bed planting	Flat planting		
Planter used for sowing maize	Raised bed planter	Tractor drawn inclined plate planter	Bullock drawn inclined plate planter	Manually operated planter
Cost of machine operation , Rs·ha-1 (Including fixed and variable costs)	472.39	538.81	119.5	115.19
% saving in labor cost as compared to traditional method	89.90%	87.98%	76.32%	75.96%
% Saving in time as compared to manual method	91.80%	91.74%	84.57%	82.46%
% Saving in irrigation water with bed planting as compared with flat planting	10-15%	----		----

CONCLUSION

Based upon the above reviews the main conclusions are the mean grain yield per ha was found maximum for raised bed maize planter as 7.017 t·ha^{-1} and for inclined plate planter and manually operated planter it was 5.778 t·ha^{-1} and 6.097 t·ha^{-1} respectively. The cost of operation per ha with raised bed, inclined and manual planters were Rs. 472.39, 538.81 and 115.19 respectively. The cost of sowing per ha with bullock drawn planter was Rs. 119.5/ha. The existing tractor drawn maize planter saves the time and cost as compared to bullock drawn and manually operated planter. The animal drawn and manually operated maize planter is economically efficient but it consume more time as compared to tractor drawn maize planter. The per cent saving in labor cost and time in maize sown with raised bed planter was 89.90% and 91.80% as compared to maize sown with traditional manual method and was highest amongst three planters. Sowing with the bullock drawn 3 row inclined plate planter is 3.5 times economical than traditional (manual method). In maize sown raised bed planter there was saving of water from 10-15% as compared to maize sown on flat with other planters. Maize planted on raised beds recorded about 7.8% higher water use efficiency than under flat layout. Raised bed planting give more advantage as compare to flat planting in the field of cost saving, time saving and water used efficiency. Review also underlines the need of sowing implement which has less cost of operation. The maize planter can be used for sowing of other crop after changing the metering mechanism.

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