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# Performance Evaluation of Mini Tractor Drawn Punch Planter for Maize Crop

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**ABSTRACT**

A mini tractor drawn punch planter was developed and performance was evaluated for maize crop. Three forward speeds (0.8, 1.3 and 1.7 km $h^{-1}$), two seed spacings (24 and 16 cm), two types of punches (type 1 and type 2) were selected to evaluate the punch planter in two different types of soil conditions ( sandy clay loam and clay with rice fallow). The seed disposing parameters like seed miss index, seeds multiple index and quality of feed index were analyzed. In sandy clay loam soils, quality of feed index was decreased from 84.9 to 83.4% and 85.8 to 84.9% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$. In clay soils with rice fallow field, the quality of feed index was decreased from 81.9 to 80.7% and 84.3 to 83.4% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$.

**Keywords:** *Punch planter, Quality of feed index, Seed miss index, Seeds multiple index.*

Maize (*Zea mays L.*) is an important cereal food crop of the world with highest production and productivity as compared to rice and wheat. It is the most versatile crop which is being grown in more than 166 countries around the globe including tropical, sub tropical and temperate regions from sea level to 3000 m MSL.

In Andhra Pradesh, Agriculture growth rate during the year 2017-18 as per first half year advance estimates about 17.44% is recorded. In kharif 2017, maize recorded all time highest productivity of 4587 kg $ha^{-1}$ eventually 29% increase in maize production *i.e.*, 21.43 lakh Mt compared to previous year. During the year 2017-18, the state stood in 2nd place in maize productivity, 3rd place in Paddy and 4th place in cotton and sugarcane in the country. Similarly, A.P stands in 2nd place in paddy, maize and groundnut production (Anonymous, 2018)

In manual dibbling method, the seeds were sown in lines with a spacing of 22-25 cm between seeds with row spacing of 60 cm. It is of general practice that holes are made in the field by using long hoe by male labour and one or two seeds were in the holes by female labour. This is highly labour consuming practice and also the cost of operation is high compared to other practices. The dibble or punch planting resulting from placing single or multiple seeds in individual holes that have been punched or otherwise dug in the seedbed. The holes are usually aligned to form rows of established plants.

A punch planter may offer better seeding performance than conventional planters for no-till conditions because it moves a minimum amount of soil and residue and offers precision in seed spacing. Minimal research has been completed to overcome some limitations that this machine concept offers, specifically mechanisms to change population rate. (Molin, 1998(a)).

The punch planting is conceptually ideal for planting because it disturbs a minimal amount of soil and is useful for crops sensitive to precision spacing. A simple method of punch planting involves placing seeds into holes instead of furrows. This technique provides a favorable environment for the seeds, which could result in uniform germination and emergence of seedlings than conventional methods of planting. That favorable environment is comprised of good contact between seed and soil. In Krishna western delta region, especially in rice fallow black soils the zero till drills are not giving good results due to heavy clay soils with stubbles.

Previously research work was done on punch planer for sowing different crops in different field conditions. The design was different by different researchers, mechanical dibber planter for planting selected seed namely maize, red gram, and cotton was developed by Jayan and Kumar (2010), punch planter for maize (Ismail and Hanify, 2009), a machine capable of planting holes for a wide variety of spacing in plastic mulch beds (Lawrence *et al.,* 2007), a punch planter with adjustable seed spacing by modifying the existing punch planter for maize (Molin, 2002, Molin and Agostini, 1996, Molin., *et al*, 1998(a))

## MATERIAL AND METHODS

Developed prototype punch planter was evaluated under two types of fields were sandy clay loam and clay soils. Three operating speeds ( 0.8, 1.3 and 1.7 $kmh^{-1}$), two types of punches ( Type 1 and Types 2 ) and two combinations of PTO and gear (P1G2 and P2G2) were selected for field evaluation. Four replications were taken in each treatment. Average

punch spacing of 24 and 16 cm were obtained with PTO and gear combinations of P1G2 and P2G2, respectively. The treatment combinations were shown in Table 1.

**Table 1. Treatment combinations for field experiment**

| PTO and gear selection | Treatment combination |
|---|---|
| P1G2 | T1S1 |
| | T1S2 |
| | T1S3 |
| | T2S1 |
| | T2S2 |
| | T2S3 |
| P2G2 | T1S1 |
| | T1S2 |
| | T1S3 |
| | T2S1 |
| | T2S2 |
| | T2S3 |

where,
P1G2= PTO lever position 1 and Gear lever position 2
P2G2= PTO lever position 2 and Gear lever position 2
T1S1 = Punch type 1 and forward speed 0.8 $kmh^{-1}$
T1S2 = Punch type 1 and forward speed 1.3 $kmh^{-1}$
T1S3 = Punch type 1 and forward speed 1.7 $kmh^{-1}$

There are six treatment combinations in each PTO and gear selection. Therefore total twelve combinations were obtained in each field condition and also each one replicated four times. An area of 28 x 21m marked and conducted performance evaluation of prototype punch planter in two different fields. The data was statistically analyzed by using mixed factorial experiment method.

**Field Evaluation Parameters**

The field evaluation of the prototype punch planter includes seed disposing performance which were expressed in different performance indices and field performance parameters viz., actual field capacity, theoretical field capacity, field efficiency, fuel consumption and ground wheel slip.

**Seed disposing performance**

To evaluate the developed prototype punch planter in the field, performance indices like seed miss index, seed multiple index, quality of feed index were considered (Moiln *et al.,* 1996 & 1998) In the length of 20 m, the data required to estimate performance indices were measured and calculated the indices as per equations.

**Seed miss index**

The seed miss index was considered as the first indicator for the seed disposing performance. It is estimated for each treatment by counting the number of punches that have no seeds and counting the number of used punches in each treatment. Then, the percentage of miss index was calculated as

$$S_m = \frac{B_n}{M} \times 100 \quad \ldots(1)$$

where,

$S_m$ = percentage of seed miss index, %
M = total number of the used punches
$B_n$ = number of punches that have no seeds

**Seeds multiple index**

The seeds multiple index was considered as the second indicator for the seed disposing performance. It was estimated for each treatment by counting the number of punches that have more than one seed and counting the number of the total punches in each treatment. Then, the percentage of seeds multiples index can be calculated as

$$S_{mu} = \frac{A_n}{M} \times 100 \quad \ldots(2)$$

where,

$S_{mu}$ = percentage of seeds multiple index, %
$A_n$ = number of punches that have more than one seed

**Quality of Feed Index**

The uniformity of the seed in row was estimated by calculating the seed miss index and the seeds multiples index. Then the percentage of the quality of feed index in row can be calculated as follows.

$$Q_{fi} = 100 - (S_m + S_{mu}) \quad \ldots(3)$$

where,

$Q_{fi}$ = quality of feed index, %

**Figure 1. Uniform spacing between plants (24 cm) in a row sown by punch planter in clay and rice fallow condition**

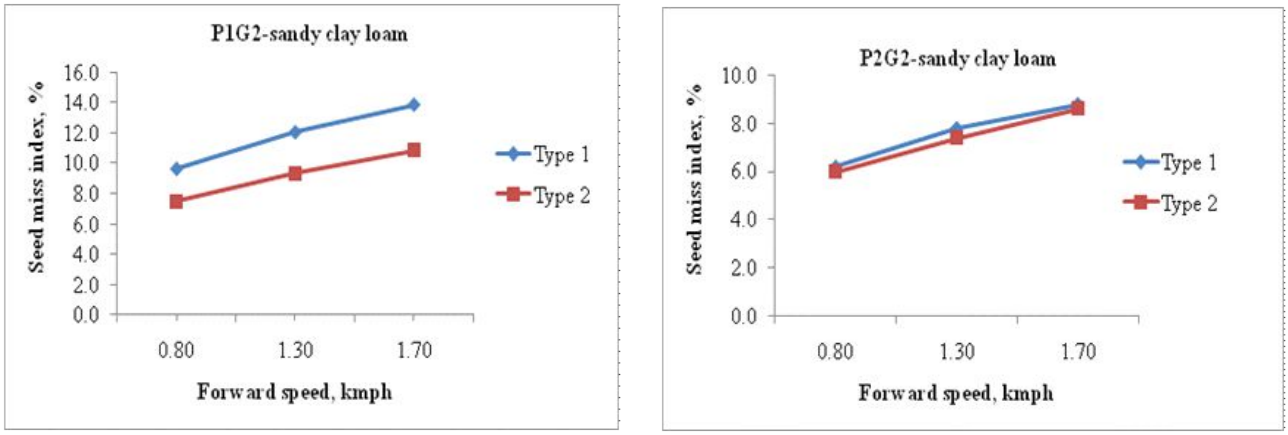


**Figure 2. Seed miss index at different speeds in sandy clay loam soil**

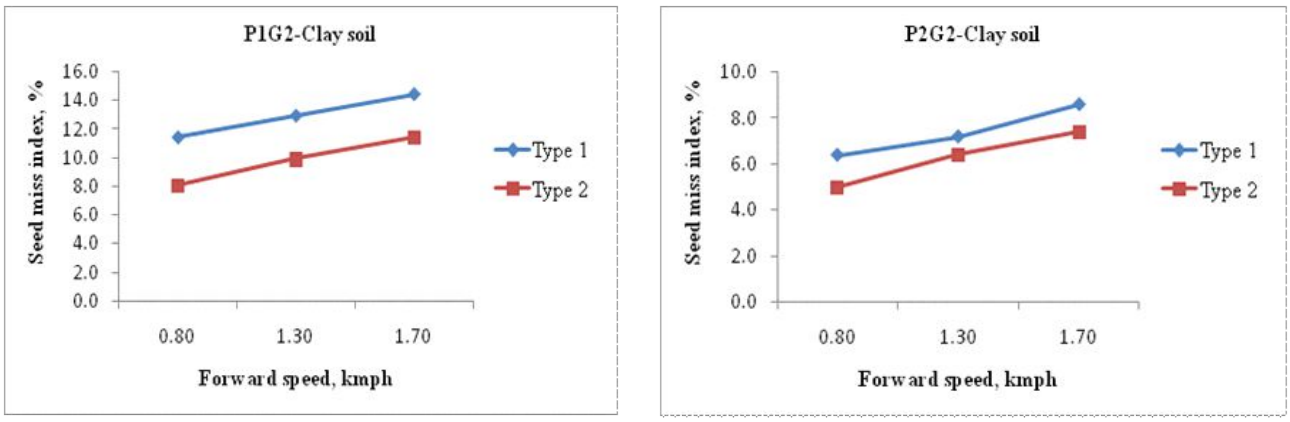


**Figure 3. Seed miss index at different speeds in clay soil with rice fallow**

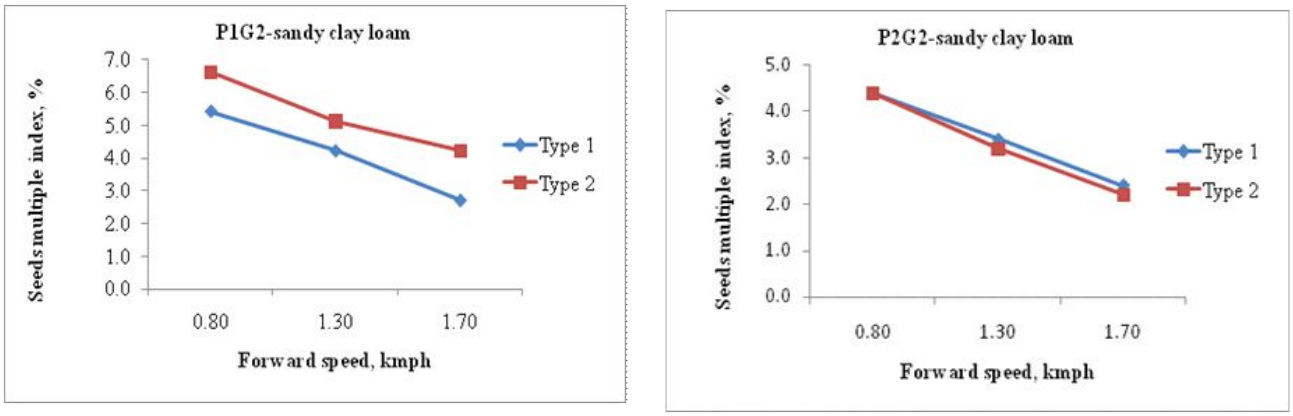


**Figure 4. Seed multiple index at different speeds in sandy clay loam soil**

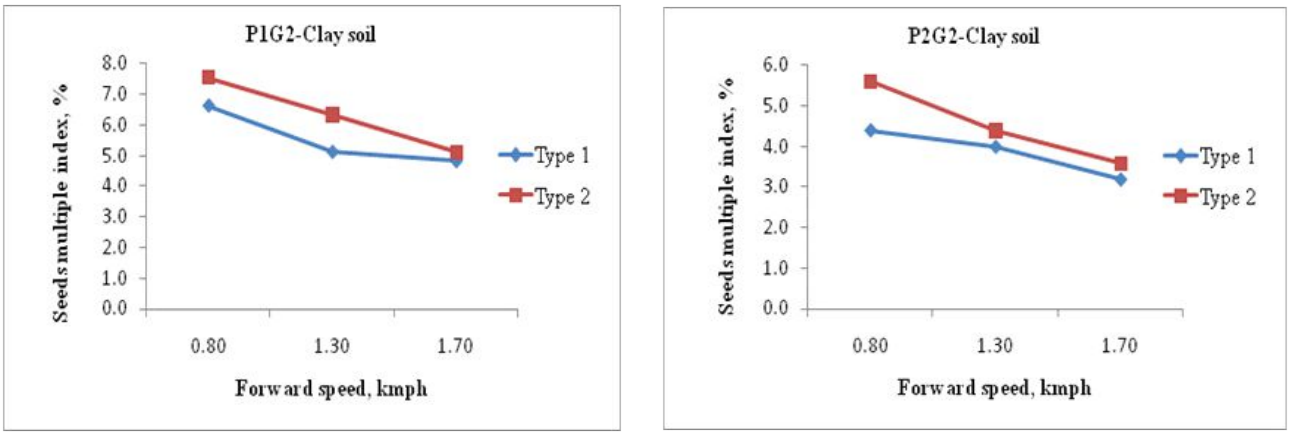


**Figure 5. Seed multiple index at different speeds in clay soil with rice fallow**

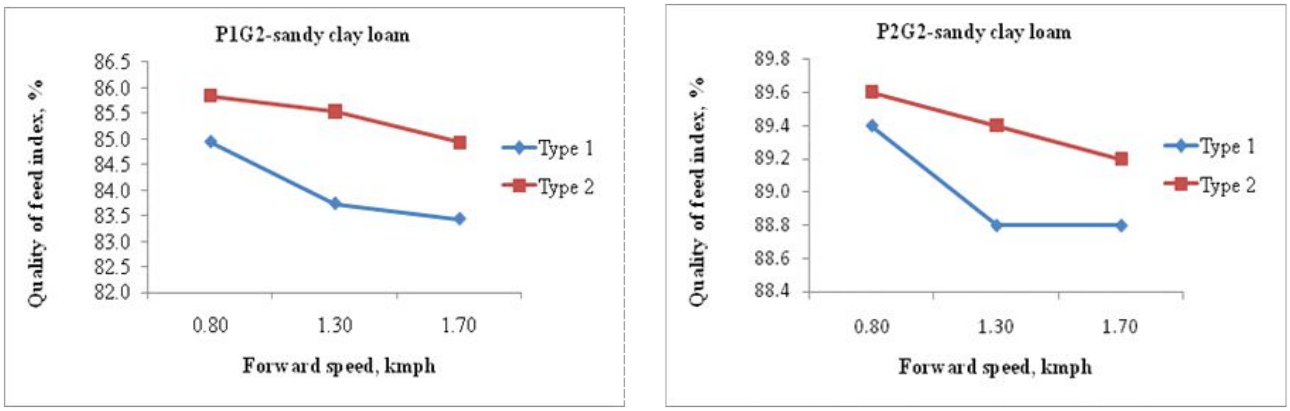


**Figure 6. Quality of feed index at different forward speeds in sandy clay loam soil**

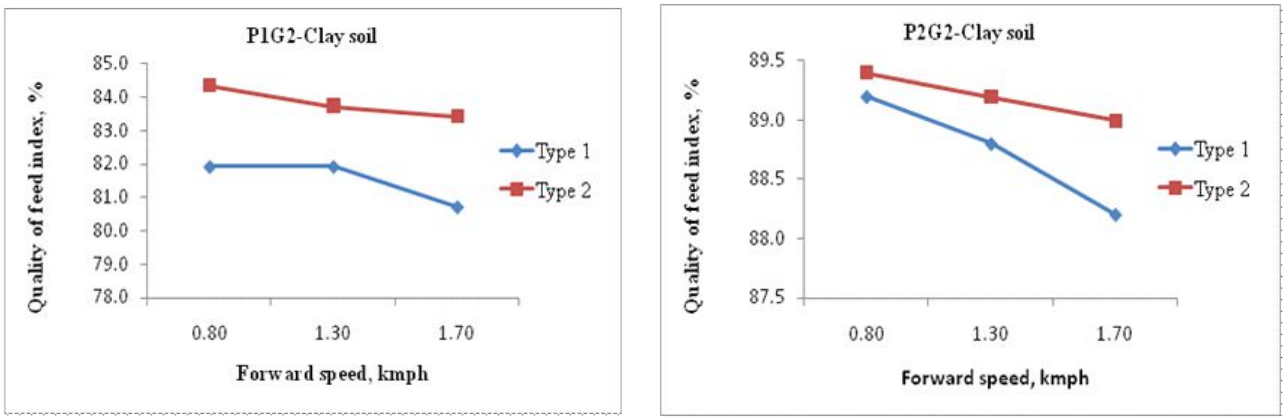


**Figure 7. Quality of feed index at different speeds in clay soil with rice fallow**

## RESULTS AND DISCUSSION

### Seed Disposing Performance

Experiments were conducted and evaluated the prototype punch planter in two types of field conditions that is in sandy clay loam soils and clay soil with rice fallow. Two seed spacing were selected to test the punch planter.

**Table 2. Selected variables and it's type for evaluation of punch planter.**

| Selected variable | Range/type |
|---|---|
| Type of field | 1. Sandy clay loam |
| | 2. Clay with rice fallow |
| Gear and PTO lever combination | 1. P1G2 for 24 cm spacing |
| | 2. P2G2 for 16 cm spacing |
| Forward speeds | 1. 0.8 $Kmh^{-1}$ |
| | 2. 1.3 $Kmh^{-1}$ |
| | 3. 1.7 $Kmh^{-1}$ |
| Type of punch | 1. Type 1 |
| | 2. Type 2 |
| Seed disposing parameters | 1. Seed miss index |
| | 2. Seeds multiple index |
| | 3. Quality of feed index |

### Seed Miss Index

The experiments were conducted and collected data in the form of mixed factorial experiment. There are three factors, first factor is punch spacing, which consists two levels ( 24 cm and 16 cm), second factor is type of the punch, which consists two levels ( type 1 and type 2) and third factor is forward speed, which consists three levels ( 0.8, 1.3 and 1.7 $kmh^{-1}$).

The results of statistical analysis showed that there is a significant effect of interaction combinations of forward speed and type of punch and forward speed and punch spacing on seed miss index in both sandy clay loam soils and clay soil with rice fallow. The relationship between the forward speed and the seed miss index for two types of punches and two punch spacings in sandy clay loam soil were represented in Figure 2.

In case of clay soils with rice fallow field, the seed miss index was increased from 11.4 to 14.5% and 8.1 to 11.4% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$. The same trend was observed for 16 cm punch spacing also. It was observed that seed miss index was increased from 6.4 to 8.6% and 5.0 to 7.4% for 16 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$ (Figure 3).

**Seeds Multiple Index**

The seeds multiple index decreased with the increase of forward speed of punch planter in both punch spacings and also for two types of punches. It was observed that in sandy clay loam soils, seeds multiple index was decreased from 5.4 to 2.7% and 6.6 to 4.2% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increases from 0.8 to 1.7 $kmh^{-1}$. The same trend was observed for 16 cm punch spacing also. It was observed that seeds multiple index was decreased from 6.6 to 3.6% and 6.6 to 3.3% for 16 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$ (Figure 4)

In case of clay soils with rice fallow field, the seeds multiple index decreased from 6.6 to 4.8% and 7.5 to 5.1% for 24 cm punch spacing and for type1 and type 2 punches respectively, on increasing speed form 0.8 to 1.7 $kmh^{-1}$. The same trend was observed for 16 cm punch spacing also. It is observed that seeds multiple index was decreased from 4.4 to 3.2% and 5.6 to 3.6% for 16 cm punch spacing and for type1 and type 2 punches respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$ (Figure 5).

**Quality of Feed Index**

The uniformity of the seed in row was evaluated by the quality of feed index. The quality of feed index decreased with the increase of punch planter speed in both punch spacings and also for two types of punches. It was observed that in sandy clay loam soils, quality of feed index was decreased from 84.9 to 83.4% and 85.8 to 84.9% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$. The same trend was observed for 16 cm punch spacing also. It was observed that quality of feed index was decreased from 84.0 to 83.1% and 84.3 to 83.7% for 16 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$ (Figure 6).

In case of clay soils with rice fallow field, the quality of feed index was decreased from 81.9 to 80.7% and 84.3 to 83.4% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$. The same trend was observed for 16 cm punch spacing also. It was observed that quality of feed index was decreased from 89.2 to 88.2% and 89.4 to 89.0% for 16 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$ (Figure 7).

**CONCLUSION**

The quality of feed index decreased with the increase of punch planter speed in both punch spacings and also for two types of punches. It was observed that in sandy clay loam soils, quality of feed index was decreased from 84.9 to 83.4% and 85.8 to 84.9% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$.

In case of clay soils with rice fallow field the quality of feed index was decreased from 81.9 to 80.7% and 84.3 to 83.4% for 24 cm punch spacing and for type1 and type 2 punches, respectively, if speed increased from 0.8 to 1.7 $kmh^{-1}$.

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