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Performance evaluation of tractor drawn onion seed planter

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Abstract
The existing onion seed planter was tested in lab of SVCAET&RS, IGKV Raipur and the seed rate, quality of feed index, multiple index, miss index, seed to seed spacing and theoretical seeding rate was found to be 9.67 kg ha^{-1} at 3 km h^{-1} with 18 plate grooves, 88.80% at 3 km h^{-1} with 30 plate grooves, 5.24% at 3 km h^{-1} with 18 plate grooves, 5.09% at 3 km h^{-1} with 30 plate grooves, 7.49 cm at 3 km h^{-1} with 18 plate grooves and 8,88,888 seeds/ha. After lab testing best combination of speed of operation (3 km h^{-1}) and plate size (18 plate grooves) was selected. The field test of existing onion seed planter was performed in instructional farm of IGKV. The theoretical field capacity, effective field capacity, field efficiency, speed of operation and plant population per hectare was found to be 0.585 ha h^{-1}, 0.462 ha h^{-1}, 78.97%, 3 km h^{-1}, and 755039 respectively. The total input energy required for onion cultivation was calculated as 13810.77 MJ ha^{1}. The cost economics of existing onion seed planter was found to be 1312.14 Rs ha^{-1}.

Keywords: Onion seed planter, onion seed, IGKV, quality of feed index, multiple indexes, miss index

Introduction
India is the second largest producer of onion after China in the world. India ranks first in area (1.19 million hectares), but the production is highest (23.93 million metric tons) in China followed by India is (22.82 million metric tons). In India, onion was grown over an area of about 12.20 m-ha with a total production of 22.82 lakh MT during 2019-20 and productivity of 1.8 t ha^{-1} during 2019-20. During the fiscal year of 2021, the volume of onion production in India is 27 million metric tons of onion. The total area under onion cultivation in Chhattisgarh is 25,542 ha with production of 4,18,119 MT in 2020-21 and Raipur district as the major producer of onion 2862 ha with a production of 50,327 MT.
A total of 27 million metric tons of production volume is estimated in the fiscal year of 2021. (Anon, 2020) [1]. The machine performs seed drilling and planting operation. The basic difference between the seed drill and planter is that a seed drill sows seeds at specified rate and at the proper depth and in rows. It can't deposit the seeds in hills nor in check rows, where as a planter can deposit seeds at a specified rate in hills and rows spaced to permit inter row cultivation and also function as a seed drill if required several studies have shown that the use of planter increase the yield by 15 to 25% and may increase up to 40% depending upon the crop variety. Increase in yield is due to uniform and controlled drilling of fertilizer with respect to seed in a concentrated band. Fertilizer is placed about 5 cm below and 5 cm away from the seed which provides good environment for root development (Nirala, 2011) [9]. In the conventional onion cultivation onion seeds are sown in nursery for further transplanting. During transplanting of onion seedlings, weeding and harvesting are the most labor-intensive operations that are presently done manually in India. In case of manual method of onion seedlings transplantations, the labor requirement is very high (i.e., 100-120 man-days/ha) with seedling populations as 8.9 lakh seedlings per hectare Rathina kumari *et al*. (2003) [10].
In view of importance of planter for onion, it is important to introduce a tractor drawn onion planter in Chhattisgarh. Hence a work on techno economic evaluation of recently purchased tractor drawn onion planter has been planned.

Material and Methods
The experiment was conducted at research farm Indira Gandhi Krishi Vishwavidyalaya Raipur.

It is situated and located between 21º'15'0.00" North latitude and 81º37'47.98" east longitude with an altitude of 298 m above mean sea level. Raipur is situated in the seventh ago-climatic region of India.

Physical Characteristics of Onion Seeds

Quality of Seeds

The factors which affect the germination of the onion seeds are the quality and variability of seed. The variety of onion seed selected for the study is N-53. The metering device plates are selected according to seed to seed spacing and size of seeds.

Measurement of average length (L), width (W) and thick ness (T)

Average length (L), width (W) and thickness (T) is calculated as followed (Mohsenin, 1986) [8].

$$L = \frac{\sum_{i=1}^{n} L}{n} \quad (1)$$

$$W = \frac{\sum_{i=1}^{n} W}{n} \quad (2)$$

$$T = \frac{\sum_{i=1}^{n} T}{n} \quad (3)$$

Were,
L = Largest intercept (length), mm.
W = Width, mm; and
T = Thickness, mm.

Miss index (MI)

When seed cells fail to pick up and transmit seeds to the drop tubes, skips or misses occur. The percentage of spacing higher than 1.5 times the theoretical spacing is represented by the Miss Index (MI) (Bakhtiari and Loghavi, 2009) [3], which is the percentage of spacing greater than 1.5 times the theoretical spacing. MI levels that are lower indicate better performance.

$$MI = \frac{\varepsilon}{N} \times 100 \quad (3.17)$$

Were,
MI = Miss Index,%
ε = The total number of observations with spacing more than 1.5 times the theoretical spacing.
N = Total number of observations.

Multiple index (DI)

When a cell delivers more than one seed, multiples are formed. The percentage of spacing that is less than or equal to half of the theoretical spacing is represented by the Multiple Index (DI) (Bakhtiari and Loghavi, 2009) [3], which is the percentage of spacing that is less than or equal to half of the theoretical spacing. Multiple values that are lower indicate better performance.

$$DI = \frac{\Psi}{N} \times 100 \quad (3.18)$$

Were,
DI = Multiple indexes, %
Ψ = Total number of observations with spacing less than 0.5 times the theoretical spacing.
N = Total number of observations

Quality of Feed Index (QI)

It is the number of observations with a theoretical spacing of 0.5 to 1.5 times. The higher the quality of the feed index, the better the metering mechanism's performance.

$$QI = \frac{\tau}{N} \times 100 \quad (3.19)$$

Where,
QI = Quality of feed index, %
τ = Total number of observations, which are 0.5 to 1.5 times theoretical spacing.
N = Total number of observations

Result and Discussion

The mean of the physical properties of onion such as length, width and thickness of the onion seeds were found to be 2.91 mm, 2.09 mm and 1.50 mm, respectively. The average sphericity of onion seed was found 0.71mm along with the geometric mean diameter of onion seeds was 2.08 mm as shown in table 1. The average value of 1000 grain onion seed weight was 3.755 g.

Table 1: Physical properties of onion seeds

Particulars	Length (mm)	Width (mm)	Thickness (mm)	Sphericity	Geometric Mean Diameter, (mm)
Mean	2.91	2.09	1.50	0.71	2.08
Range	2.78-3.02	1.79-2.36	1.23-1.92	0.67-0.76	1.89-2.25
SD	0.07	0.12	0.18	0.03	0.11
CV%	2.42	5.87	11.82	3.97	5.3

Machine parameter

Effect of forward speed and type of seed metering plate on seed to seed spacing

The effect of forward speed in seed to seed spacing is shown in fig.1 it interprets that on increasing forward speed the seed to seed spacing was observed to be increased. This has been also observed by Grewal *et al*., *(*2015) [7]. Also, on increasing the 6 plate grooves from 18 to 24 and 30 the seed to seed spacing decreased by 22%. As shown in table 2 the trend average seed to seed spacing observed were 5.89, 7.49, 9.44 for 18 groove plate 4.59, 6.90, 8.33 for 24 groove plate 3.46, 6.16, 7.85 for 30 groove plate at forward speed of onion seed planter 2.0, 3.0 and 4.0 km h-1 respectively. Since on increasing the speed the exposure time for the onion seed in the groove reduces this enhances the seed to seed spacing. This type of trend has been shown by Gautam *et al*. (2016) [4] that on increasing the forward speed seed to seed spacing increase. The data as shown in table 2 the average seed rate observed were 6.00, 4.98, 3.50 for 18 groove plate 7.62, 6.47, 5.48 for 24 groove plate 11.36, 9.67, 7.52 for 30 groove plate at forward speed of onion seed planter 2.0, 3.0 and 4.0 km h^{-1} respectively. The data in fig. 2(a) revealed that on increasing forward speed the seed rate was observed to be decreased.

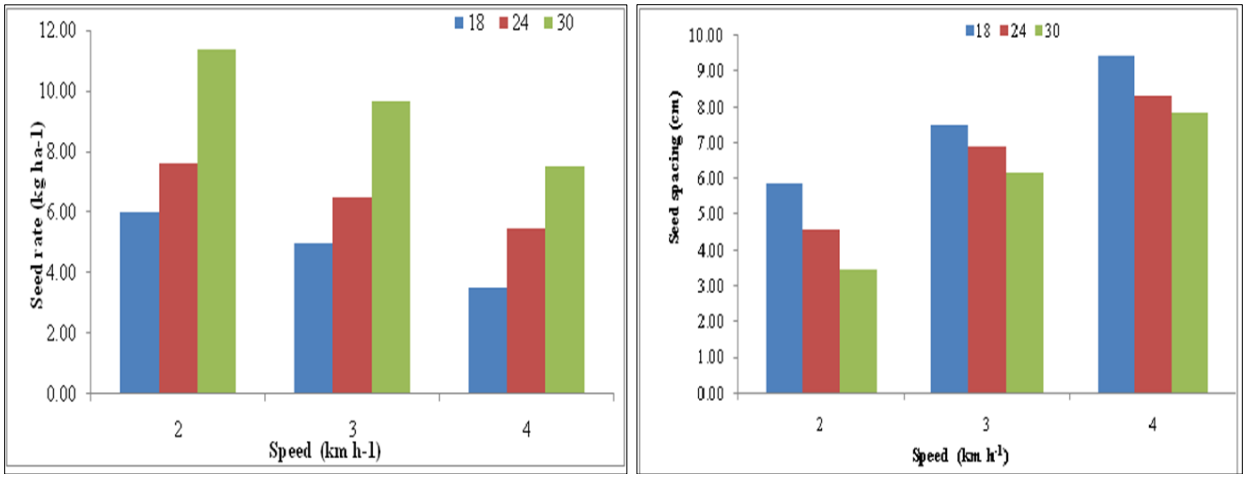

Fig 1: Effect of forward speed and type of seed metering plate on (a) seed rate (b) seed spacing

The grooves from 18 to 24 and 30 the miss index decreased by 11%. As shown in table 2 the trend average miss index observed were 5.98, 7.13, 11.29 for 18 groove plate 5.32, 6.08, 10.90 for 24 groove plate 4.86, 5.09, 8.73 for 30 groove plate at forward speed of onion seed planter 2.0, 3.0 and 4.0 km h^{-1}respectively. Since on increasing the speed the exposure time for the onion seed in the groove reduces this enhances the miss index. The average quality of feed index observed were 86.43,87.63 and 84.82 for 18 groove plate, 85.79, 88.13 and 85.01 for 24 groove plate, 84.60, 88.80 and 86.49 for 30 groove plate at forward speed of 2.0, 3.0 and 4.0 km h^{-1} respectively. As shown in table 2 the effect of forward speed in multiple indices is shown in fig. 4.4 it interprets that on increasing forward speed the multiple indexes was observed to be decreased. Since on increasing the speed the exposure time for the onion seed in the groove reduces this enhances the multiple indices.

Table 2: Effect of forward speed and type of seed metering plate on different parameters

Speed (Km h^{-1})	Plate grooves	Average seed to seed spacing (cm)	Miss index (%)	Multiple index (%)	Quality of feed
	18	5.89	5.98	7.59	86.43
2	24	4.59	5.32	8.89	85.79
	30	3.46	4.86	10.54	84.60
	18	7.49	7.13	5.24	87.63
3	24	6.90	6.08	5.79	88.13
	30	6.16	5.09	6.18	88.80
	18	9.44	11.23	3.89	84.82
4	24	8.33	10.90	4.09	85.01
	30	7.85	8.73	4.78	86.49

Conclusion

- Onion seed planter has 13 rows spacing of 15cm and 195 cm wide. Depth is control by control wheels.
- The physical properties of onion such as average length, width, thickness, sphericity, geometric mean diameter, weight of 1000 seed, bulk density, true density, porosity and moisture content were recorded. It was found 2.91 mm, 2.09 mm, 1.50 mm, 0.71, 2.0 8 mm, 3.76 g, 446.91 kg m^{-3}, 846.03 kg m^{-3}, 47.15%.
- Minimum value of multiple indexes was 6.18% at speed of 3 km h^{-1} for 30 grooves plate.
- Maximum quality of feed index was 88.80% for 30 groove plate at the forward speed of 3 km h^{-1}

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