www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(1): 131-136

www.thepharmajournal.com
Received: 18-11-2022
Accepted: 20-12-2022

GV Kambale
M.Tech Scholar, Department of Farm Machinery and Power Engineering, CAET, VNMKV, Parbhani, Maharashtra, India

Dr. PA Munde
Associate Professor, Department of Farm Machinery and Power Engineering, CAET, VNMKV, Parbhani, Maharashtra, India

Dr. SN Solanki
Head, Department of Farm Machinery and Power Engineering, CAET, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
GV Kambale
M.Tech Scholar, Department of Farm Machinery and Power Engineering, CAET, VNMKV, Parbhani, Maharashtra, India

Performance and evaluation of VNMKV, UAE developed bullock drawn turmeric planter

GV Kambale, Dr. PA Munde and Dr. SN Solanki

DOI: https://doi.org/10.22271/tpi.2023.v12.i1b.18335

Abstract
Turmeric is an important spice crop cultivated in Maharashtra. Turmeric (*Curcuma longa* L.) are the oldest rhizome crops widely cultivated in India. At present, it is observed that the farmers in the state had faced problems in turmeric planting due to lack of labour shortage. Turmeric rhizomes are planted by manually in the furrows by dibbling at a spacing of 30 x 30 cm, and 15 x 15 cm. After dibbling the rhizomes are covered with the loose soil by the hand. Manual planting of turmeric is both labors intensive and costly, resulting in various problems for farmers. During manual planting, the labors have to dig the soil to sow turmeric. This method is time consuming, labour intensive, associated with human drudgery and a high demand for human energy. The traditional system has the limitations of uneven depth of rhizomes placement, slow ground coverage and high labour requirement. Therefore, a mechanical rhizome planter is required for planting of turmeric. Therefore, the present study was undertaken to performance and evaluation of UAE developed bullock drawn turmeric planter. The rhizome planter was designed to suit various soil types and conditions to perform several functions simultaneously by opening the furrows, planting of rhizomes and covering of rhizomes by soil and forming ridges in single pass.
The performance evaluation of UAE developed bullock drawn turmeric planter was tested for different forward speeds. Performance indices such as missing index (Imiss), rhizome multiple index, rhizome spacing, draft, horse power, theoretical field capacity, effective field capacity and field efficiency were used to evaluate performance of turmeric planter. The mean spacing for turmeric was ranged 15 to 32 cm respectively. The optimum performance for planting turmeric was at a forward speed of 1.2 km/hr to 1.55 km/hr. The average field capacity and efficiency was 0.30 ha/ hr and 93.33%. The average seed rate obtained 437.5 kg/ha, depth of placement 4-7 cm and draft requirement is 68.43 kgf was obtained. The savings in cost and time for mechanical planting was about 59.52% and 96.57% compared to manual planting. Based on the performance evaluation results, it is concluded that the developed rhizome planter is economical and efficient for turmeric planting.

Keywords: Turmeric rhizome, miss and multiple index, seed rate and speed

Introduction

Turmeric (*Curcuma longa* L.) plant is a perennial herb belonging to the ginger family Zingiberaceae, has primary and secondary rhizomes of different forms, from spherical to slightly conical, hemispherical and cylindrical. The rhizome is deep bright yellow in colour. Turmeric was derived from Latin word terra merita (merited earth). Turmeric is an important spice grown in India since ancient times. It is referred as Indian saffron and commonly called as Haldi. Turmeric is also called as yellow gold. India is the largest producer, consumer and exporter of turmeric in the world.

Turmeric rhizomes are planted in the furrows by dibbling at a spacing of 30 x 30 cm, and 15 x 15 cm. After dibbling the rhizomes are covered with the loose soil from the ridge. The capacity of man is very low about 0.05 ha. /man/day and payment for planting is 11.9 percent of total cost of production. Because of the high costs of the traditional methods of turmeric planting, cultivation and harvesting which is very time consuming and labor intensive, its large-scale production is not economical and is therefore very limited. The manual method of seed planting, results in low seed placement, serious back ache, need for huge labor source, high labor cost and drudgery in their work. This results in inadequate and non-uniform plant stand. This practice not only results in higher planting material cost but also lower the crop yield. The traditional system has the limitations of uneven depth of rhizomes placement, slow ground coverage and high labour requirement.

The developed implement is expected to improve the timeliness and efficiency of operation as well as reduce drudgery and cost of turmeric production. The availability of easy to use bullock drawn turmeric planter for farmers can alleviate these problems substantially, and can also help to maintain timely planting and reduce the farmers' drudgery. At present, it is observed that the farmers in the state had faced problems in turmeric planting due to lack of labour shortage. Therefore, it is essential to develop a rhizome planter for mechanizing planting of turmeric, with bullock for small and marginal farmers. Mechanizing planting operation results in uniform plant spacing, depth and aids further mechanization of intercultural operations that will reduce the total production cost and increase yield and productivity.

Materials and Methods

Fig 1: Specification of Bullock drawn turmeric planter

Table 1: Specification of Bullock drawn turmeric planter

Sr. No	Particular	Specification
1	Overall dimension (l X wX h), cm	159 X49 X 90
2	Height of furrow opener, cm	36
3	Seed hopper, cm (l X wX h)	35 X 30 X 26
4	Row to row spacing, cm	60
5	Number of rows	2
6	Working width, cm	120
7	Ground wheel diameter, cm	46
8	Depth control wheel/ Transport wheel (Side wheel) diameter, cm	100

An experiment on performance evaluation of UAE developed bullock drawn turmeric planter at the Department of Farm Machinery and Power Engineering and AICRP on UAE, College of Agricultural Engineering and Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2021-22. The performance variables study of field operation, speed of operation and cost of comparison of developed planter with respect to traditional methods. These variables were examined to study miss index, multiple index, seed spacing, seed damage and germination percentage. The variables were examined to study bulk density of turmeric, draft, depth of seed placement, seed rate, seed spacing, Miss Index (%) is, Multiple Index, Germination percentage, Effective Field Capacity, Theoretical Field Capacity, Field Efficiency, Draft is, Speed, Ground wheel slippage, Moisture content. After optimization and selection was the metering mechanism, the calibrations of planter were carried out. The field experiment was carried out during the end of June 2022 seasons in order to evaluate the performance and evaluation of two row Turmeric planter in field.

Performance evaluation of UAE developed bullock drawn turmeric planter

Laboratory Test

Before conducting the performance evaluation of the unit in the field, laboratory test, were carried out for obtaining the correct rhizome rate and seed damage rate.

Calibration Test

The performance of the bullock drawn turmeric planter was tested in the laboratory. The calibration of developed planter was carried out in the laboratory to check it for its desired seed rate and percentage of seed damage. Laboratory testing of planter was carried out in the workshop in order to study the flow rate of Fingers in the Turmeric planter.

Following steps were followed for calibration test.

1. Circumference of ground wheel was calculated.
2. Determine the nominal width of planter.

$$W = M \times S$$

Where,

M= number of furrow openers

S= Spacing between the furrow openers, m

Find the length of the strip (L) having nominal width W necessary to cover 1/25th of a hectare.

$$L = \frac{10000}{W} \times \frac{1}{25}$$

Determine the number of revolutions (N) the ground wheel has to make to cover the length of the strip (L).

$$\Pi \times D \times N = \frac{10000}{W} \times \frac{1}{25}$$

Where,

D = diameter of the ground wheel. M

$$N = \frac{10000}{\Pi \times D \times W} \times \frac{1}{25}$$

$$N = \frac{400}{\Pi \times D \times W}$$

Number of revolutions required to cover 1/25th area of one hectare was calculated. This was calculated by dividing 10,000 m^2 by the area covered in one revolution by the ground wheel.

The ground wheel was made free to rotate by raising planter. Jack up the planter so that the ground wheels rotate freely. Make a mark on the drive wheel and a corresponding mark at convenient place on the body of the planter to help in counting the revolutions of the drive wheel. Mark was put on the wheel so that revolution may be counted easily. Hopper was filled with Turmeric Fingers.

Then for fixed number of revolutions determined in step 4, the weight of Fingers collected below each furrow opener was measured.

Rotate the drive wheel at the speed N.

$$N = \frac{400}{\Pi \times D \times W}$$

Weigh the quantity of rhizome dropped from each opener.

Calculate the rhizome dropped in kg/ha.

Area covered by Turmeric planter was calculated by following formula

$$A = (\pi DN) \times W$$

Where,
A = Area covered by planter, m^2
D = Diameter of ground wheel, m
N = Number of revolutions of ground wheel
W = Width of operation, m.

Field performance test
Turmeric Planter was tested in field and following different parameters was tested which help to evaluate the planter performance in different field conditions.

Angle of pull
The angle of pull was calculated from the height measured from ground level to the part of the neck where yoke is placed and the length (base) was measured between forefront of the planter and perpendicular point to height at ground. From value of base and height the hypotenuse was calculated.

$$\text{Hypotenuse (a)} = \sqrt{(base)^2 + (height)^2}$$

Then the angle of pull is calculated by the formula,

$$\cos\theta = \frac{\text{base}}{\text{a}}$$

Draft
A digital dynamometer was attached between animal yoke and planter to measure the pull. The draft is defined as horizontal component of pull parallel to line of motion. The draft was calculated by measuring pulling force along the line of pull and its inclination angle. The pulling force was measured by the spring dynamometer having capacity ranging from 0-100 kg, with least count of 1 kg. It was attached between the beam and yoke. One hook of the dynamometer was tied with the yoke and another with the beam of implement in such a way that pulls is exerted through the dynamometer. After calculating the angle of pull the draft was determined by using the formula.
This was given by,

$$D = P \cos\theta$$

Where,
D = Draft in kgf
P = Pull in kg
θ = Angle of pull with horizontal

Speed of operation
Speed of bullocks during operations was measured with the help of stop watch by recording the time to cover 20 m linear distance. Speed were calculated with the help of following formula,

$$\text{Speed (S)} = \frac{L}{T} \times 3.6$$

Where,
S = Speed in km/hr.
L = Distance moved or travelled in meter
T = Time required by the bullock to travel certain distance in second.

Horse Power
Horse power is the multiplication of draft and speed. Values of the horse power were computed from equation.

$$\text{Horse Power (HP)} = \frac{D \times S}{75}$$

Where,
D = Draft developed, kg,
S = Speed of operation, m/s

Ground wheel slippage
The wheel slippage of bullock drawn planter was measured by marking the sides of wheels by numbers for a distance of 20 m load and in planting condition was recorded to determine wheel slip. The wheel slippage was computed in percentage and measured by using the formula.

$$\text{Wheel slippage (\%)} = \frac{N1 - N2}{N1} \times 100$$

Where,
N1= No. of rotation of side wheel of planter in 20 m distance at load condition.
N2= No. of rotation of side wheel of planter in 20 m distance at no load condition.

Field performance evaluation of developed planter
Theoretical field capacity
Theoretical field capacity of row planter is the rate of field coverage that was obtained if the planter performing its function 100% of the time at the rated forward speeds and covers 100% of its rated width. It is expressed as hectare per hour and determined as follows (Kumar Satish *et al.* 2017) [14].

$$\text{TFC} = \frac{W \times S}{10} \text{ ha/hr.}$$

Where,
TFC = Theoretical Field capacity, (ha/hr.)
W = Effective width of implement, (m)
And S = Speed of operation, (km/hr.)

Effective field capacity
For calculating effective field capacity, the time taken for actual work and that lost for other activities such as turning, cleaning, refilling of seed box, adjustment of machine and time spend for machine trouble were taken in to consideration. The length and width of plot was measured and area covered in that time was calculated. By calculating the area covered per hour. Effective field capacity of the planter was actual rate of work covered by the planter based upon the total field time and a function of rated width of the machine actually utilized and expressed as hectare per hour (Kumar Satish *et al.* 2017) [14].

$$\text{EFC ha/hr.} = \frac{A}{T}$$

Where,
EFC = Effective Field capacity, (ha/hr.)
A = Actual area covered, ha.

And T = Time required to cover the area, hr.

Field efficiency

Field efficiency is the ratio of effective field capacity to theoretical field capacity. It was expressed in percentage. It was determined by the following formula (Kumar Satish *et al*. 2017) [14]

$$FE\ (\%) = \frac{EFC}{TFC} \times 100$$

Where,
FE = Field efficiency (%)
EFC = Effective field capacity, (ha/hr.)
And TFC=Theoretical field capacity, (ha/hr.)

Seed rate

The seed rate was determined by taking the weight of seeds before and after sowing operation. Then subtracted the final weight of seed from initial weight of seed so that the seed rate was obtained and the results were expressed in terms of kg ha^{-1}. This will be established considering the weight of seeds planted per hectare area of the plot mass.

$$\text{Seed rate Kg / ha} = \frac{\text{Mass}}{\text{Area of the plot}}$$

Multiple index (DI)

Multiples are created when more than one seed is delivered by a cell. The multiples percentage is represented by an index called Multiple Index (DI) (Bakhtiari and Loghavi, 2009) [15] which is the percentage of spacing that is less than or equal to half of the theoretical spacing. Smaller values of DI indicate better performance.

$$DI = n_1/N \times 100$$

Where,
N = Total number of observations, and
n_1= Number of spacing's in the region less than or equal to 0.5

Miss index (MI)

Miss index is an indicator of how often a seed skips the desired spacing. Skips or misses are created when finger strips fails to pick up and deliver finger to the outlet. The missing percentage is presented by an index called the Miss Index (MI) (Bakhtiari and Loghavi, 2009) [15] which is the percentage of spacing greater than 1.5 times the theoretical spacing. Smaller values of MI indicate better performance.

$$MI = n_2/N \times 100$$

Where,
N = Total number of observations, and
N_2= Number of spacing's in the region >1.5 times of the Theoretical spacing

Results and Discussion

Calibration of planter by giving 25 revolutions to the ground wheel for turmeric seed

The rhizome seed requirement hectare area was determined by calibrating the rhizome planter in the laboratory for turmeric. The rhizome planter was calibrated to determine the rhizome seed rate per hectare as described in section. We have got four tests of calibration and observed different seed rate and seed damage percentage. The ground wheel was rotated for 25 revolutions and metered rhizomes were collected from the entire two furrow opener, rhizome seed rate was calculated and the results are given in table 1.

Table 2: Calibration of turmeric planter

Sr. No	Seed filling capacity in hopper	Furrow opener no	Weight of seed collected	Calculation of seed rate from both opener, kg/ha	Average seed rate, kg/ha
1	25%	1	3997		
		2	3989	1842 kg/ha	
2	50%	1	3991		
		2	3998	1843 kg/ha	1843.605 kg/ha
3	75%	1	3993		
		2	3994	1843.210 kg/ha	
4	100%	1	3999		
		2	4001	1846.210 kg/ha	

In case of turmeric, the recommended rhizome seed rate per hectare is 2000-2500 kg. However, the rhizome planter reduced the rhizome average seed rate to 1843.605 kg/ha for rhizome spacing of 30 cm. Above mentioned table were observed the lowest seed rate for 25% seed hopper filling capacity is 1842 kg/ha and highest seed rate for 100% of 1846.210 kg/ha. The average seed rate was observed 1843.605 kg/ha. Since the rhizomes length has been reduced to 40 to 50 mm for mechanical planting.

In calibration, total four replications were taken in which weights of seed collected from each opener varied from 3989 gm to 4001 gm. There was no remarkable variation of seed rate among the furrow openers for four replications. The average seed rate for each furrow openers calculated from all observations in four replications was found to be 1843.605 kg/ha. The total average seed rate from four replication of capacity of hopper was about 1843.210 kg/ha which was approximately equal to field trialled seed rate 1844 kg/ha from four replication.

Performance evaluation of bullock drawn turmeric planter

Table 2: Results of the performance evaluation of bullock drawn turmeric planter

Sr. No	Particulars	Values
1	Speed of operation, kmph	2.55
2	Effective working width, cm	1.2 m
4	Depth of placement of seed, cm	4-7
5	Recommended seed rate, ha/hr	2000-2500
6	Obtained seed rate, kg/hr	1843.210
7	Theoretical field capacity, ha/hr	0.30
8	Effective field capacity, ha/hr	0.28
9	Field efficiency, %	82.02
10	Obtained Plant population, No/ha	33,333.
11	Recommended plant population, No/ha	35,567

Effect of speed on Miss Index and multiple index

The data from Table reveal that the percentage of miss index increased by increasing the forward speed. However, increasing forward speed from 1.2 to 1.98 km/h, tends to increase the percentage of missing hills from 5.4 to 12.38 percent. Increased percentage of loss may be due to the jerk or vibration, which produced empty spoons during operation with the increase of speed. The highest Miss index (12.38%) was observed for 1.98 km/h speed, whereas the lowest miss index (5.4%) was for at 1.2 km/h speed.

Multiples are created when more than one seed is delivered. Smaller value of the multiple index indicates better performance of the machine. The mean values of observations recorded for multiple index at the speed of 3.79, 4.06 and 4.17% for respectively speed.

Table 3: Effect of speed on miss index and multiple index

Sr. No	Speed (A), km/h	Miss index	Average	Multiple index	Average
1	1.2	5.4		3.79	
2	1.55	9.1	8.96	4.06	4.00
3	1.98	12.38		4.17	

Fig 2: Field performance of bullock drawn turmeric planter

Comparison of cost of planting in the developed planter with respect to traditional planter.

Different methods of planting like ridge planting by bullock drawn turmeric planter and manual planting by hand dibbling were compared in terms of effective field capacity, labour requirement, seed rate, yield and cost of operation. The data obtained is presented in Table 4:

Table 4: Comparison of cost of planting in developed planter with respect to traditional planter

Particular	Method of planting		Remarks
	Bullock drawn turmeric planter	Manual by hand dibbling	
EFC, (ha/h)	0.29	0.0019	
Labour Required (Man-h/ha	2	65	
Cost / hour, (Rs)	221.29	50	
Cost / ha, (Rs	1882	13000	85.53 (% saving)
Seed Rate, kg/ha	1882.210	2470	20 (% saving)

The test result shows that the planter has effective field capacity of 0.23 ha/h with field efficiency having 82%. Whereas the overall miss index was found to be 7.2% and multiple indexes is 9.2%. It was also recorded that the machine required 6.94 hours to complete 1 hectare of land. Table 4 shows the comparison of the cost of operation between planter and hand dibbling of turmeric fingers. The results indicated that turmeric finger planter requires only Rs.1882 per ha for planting of turmeric whereas, manually by hand dibbling requires Rs. 13000. The machine cost was taken including the hiring cost of bullocks. The annual use of the machine was taken only 300 h per year.

Conclusions

1. The farmers face a lot of labour and management problems in ginger and turmeric cultivation. It requires about 200-250 man hours per hectare for planting operation.
2. Therefore, the present study was undertaken to performance evaluation of bullock drawn turmeric planter for turmeric planting in ridge and furrow pattern of cultivation.
3. The planting parameters considered were row spacing of 60 cm, plant to plant spacing of 15 to 30 cm.
4. The rhizome planter was developed based on the agronomic planting considerations, engineering and physical properties of rhizomes.
5. The developed rhizome planter was field tested with three different forward speeds and performance planter parameters spacing indices which include, rhizome missing index, rhizome multiple index in rhizome spacing were used to evaluate functional performance rhizome planter.
6. For turmeric, the minimum values of missing index 9.77%, multiple index 3.15%.
7. The average depth of rhizome planting was 6.6-7.1 cm which is within the recommended value of 4 to 10 cm for turmeric.

References

1. Bombale V. Performance evaluation of tractor drawn turmeric planter, International Journal of innovative trends in engineering. 2020;70(94):2395-2946.
2. Chukwudi M, Gbabo A, Nwakuba N. Field performance analysis a tractor of drwan turmeric rhizome planter. Field performance analysis of Agricultural Engineering. 2019;(2):33-46.
3. Dhoke AS, Biwal SB, Sutkar PD. Performance

evaluation of bullock drawn planter with low cost metering device International Journal of Agricultural Engineering. 2015;8(1):136-139.
4. Gbabo A, Muogbo CP, Gana IM. Development of tractor drawn turmeric planter. International Journal of Emerging Engineering Research and Technology. 2020;8(2):1-8.
5. Manish Kumar, Din M, Rama Kant Tiwari. Animal drawn garlic (*Allium sativum*) planter suitable for animal based farming system. Indian Journal of Hill Farming. 2019;32(1):113-117.
6. Madhusudhan BS, Preetham MN. Design development and performance evaluation of manually operated groundnut planter. International Journal of Ecology. 2020;47(3):858-858.
7. Prerana Priyadarsini Jena, Suryakanta Khandai. Performance evaluation of bullock drawn three-row inclined plate planter. International Journal of Current Microbiology and Applied Sciences. 2017;6(11):1545-1553.
8. Reddy Madhusudhan RD, Vijay Kumar B, Ravindranatha Reddy B. Development and performance evaluation of bullock drawn groundnut planter for winter-summer sowing. Society for recent development in agriculture. 2015;15(1):48-53.
9. Solanki SN, Thakare SH, Ramteke RT. Design development and performance evaluation of garlic planter. International conference on sustainable agriculture production for food, nutrition and livelihood security. c2019, p.1094-1096.
10. Solanke KR, Tekale DD, Kadam DM. Performance evaluation of bullock drawn cotton planter cum fertilizer drill, An international refereed & indexed quarterly. Journal in Science, Agricultural Engineering. 2016;6:2277-7601.
11. Nirala SK. Performance evaluation of bullock drawn multi crop inclined plate planter. International Journal of Agricultural Engineering. 2011;4(2):193-199.
12. Victor VM, Jogdand S. Development and Performance Evaluation of Animal Drawn Raised Bed Planter. Development, 2016, 5(8).
13. Zilpilwar S, Yadav R. Performance evaluation of tractor operated garlic (*Allium sativum* L.) clove planter. Journal of Agricultural Engineering. 2021;58(1):1-14.
14. Venegas C, Kumar S, Franklin BS, Dierkes T, Brinkschulte R, Tejera D, Vieira-Saecker A, Schwartz S, Santarelli F, Kummer MP, Griep A. Microglia-derived ASC specks cross-seed amyloid-*β* in Alzheimer's disease. Nature. 2017 Dec 21;552(7685):355-61.
15. Bakhtiari MR, Loghavi M. Development and evaluation of an innovative garlic clove precision planter. Journal of Agricultural Science and Technology. 2009 Apr 10;11(2):125-136.