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Development and testing of a self propelled coleus harvester

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Abstract : A self propelled coleus (*Solenostemom rotundifolius*) harvester was developed to alleviate the drudgery of farmers associated with harvesting of coleus. The harvester consists of a frame made of GI pipes with propelling and harvesting units mounted on it. The propelling unit is a 2- stroke engine of 7.5 bhp drives the ground wheel with a chain and sprocket mechanism. The harvesting unit is attached to the main frame by an extension of MS angle, which can be dismantled if needed. The harvester was tested in a field of 40 m^2 with three different types of tynes *viz*., angular, flat and cylindrical. The specific fuel consumption increased with load and was found maximum in flat tynes and minimum in cylindrical tynes. The effective field capacity was the highest for cylindrical tynes with 0.0764 ha h^{-1}. The highest harvesting efficiency was found to be 80.12 per cent for angular tynes.

Key words : Coleus, Harvester, Tuber crop, Rhizome harvester, Chinese potato

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Coleus (*Solenostemom rotundifolius*) commonly known as Chinese potato, is a minor tuber crop of tropical regions of India, Indonesia, Malaysia, Sri Lanka and Africa (Peter, 2007). The nutritive status of coleus is favorably good compared with many of the major crops. Low cost of cultivation, high production potential, consumer preference, good market demand and almost assured high returns make the crop highly popular among vegetable growers. It is usually planted on raised beds at a spacing of 30 cm x 15 cm at a depth of 4 to 5cm. Harvesting is done when the haulms dried, mostly 4 cm to 6 months after planting (Kerala Agricultural University, 1999). Tubers are taken out from the soil using spade and forks. The manual harvesting of coleus is laborious and tedious work. Thus a self propelled coleus harvester was developed to alleviate the drudgery of workers and to reduce the cost of production. The developed harvester was tested and evaluated for its performance in the field using different tynes.

METHODOLOGY

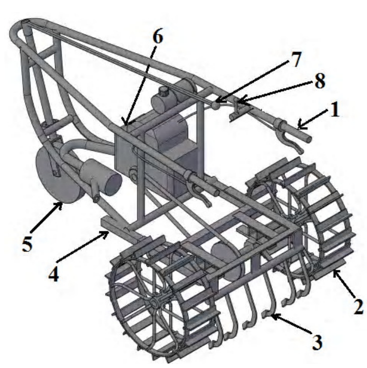
The harvester comprises of two parts *viz*. the propelling and harvesting unit. The prime mover is a 2-stroke 7.5 hp petrol engine. The use of such engine as the prime mover to the harvester proved to be advantageous for a wide variety of reasons like, the compactness and smaller in size, helped to move on narrow terrains, easy operation for women and ensured the smooth mobility. The engine drive is taken and speed is reduced to 12 times by using a reduction gear mounted on a shaft. This drive is further taken to the ground wheel with a chain and sprocket mechanism. Through this, the speed is reduced to 4 times to the cage wheel ensuring a walk-able speed for easy operation. The harvester is provided with a supporting wheel at the front end. The engine and the transmission unit are mounted on the main frame made of Φ 30 GI pipes.

The harvesting unit consisted of a frame made of MS angle of size 35 x 35 x2 mm fitted with tynes. It is attached to the propelling unit by extending the MS angle to a length of 22 cm. The specification of the harvester is shown in Table A. The slots provided at the rear end of the main frame helped to adjust the operating depth of tynes. The performance of harvester was evaluated with three types of tynes made of mild steel angle, flat and rod. Also these tynes are provided with a slight bending for better penetration and earthing up of rhizomes from the soil. In each type, 6 tynes were placed at equidistance from each other (Fig. A and B) in the harvesting unit.

The harvesting unit consists of tynes fitted on a frame attached to the rear end of the harvester. The cutting tynes are flat, angular and cylindrical types. The adjustments were done at various operating depths of 7, 9 and 11 cm. Power was

Table A : Specification of coleus harvester

Items	Specifications
Overall length	150 cm
Height	100 cm
Weight	55 kg
Power transmission unit	Chain and sprocket
Main frame	GI pipe of Φ30
Engine	
Type	2 stroke, Petrol
Cooling type	Air cooled
Displacement	145.45 cc
Max. power	7.5 bhp(5.93 kW) @ 3500 rpm
Max. torque	10.8 Nm @ 2500 rpm
Labour requirement	1 person
Harvesting unit	
Harvesting unit	MS angle of size 35x 35 x 3 mm
Tynes (Types)	Material used – Mild steel
	Flat : 250×35 × 7 mm
	Angular : 250×36 ×7 mm
	Cylindrical rod of length 250 mmx Φ5
Supporting wheel	Pneumatic wheel of Φ 150



1	Handle
2	Ground wheel
3	Tyne
4	Frame
5	Supporting wheel
6	Engine
7	Directing lever
8	Accelerator

Fig. A : Isometric view of self propelled coleus harvester

transferred from driving shaft to the driven shaft by means of chain and sprocket. In order to reduce the engine speed to a controlled level, sprocket of larger diameter containing 42 teeth was used. The maximum power required for harvesting, considering all kinds of losses was worked out to be 7.5 hp.

Performance evaluation of harvester:

Measurement of fuel consumption:

A measurable fuel tank was filled and connected to the engine. The fuel consumption at each run of the harvester was measured directly by monitoring the level difference during the field trials (Fathollahzadeh *et al.*, 2010).

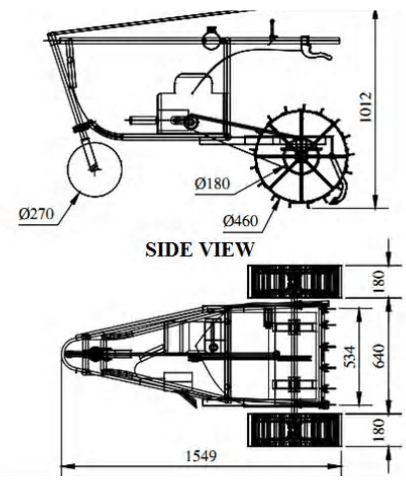


Fig. B : Orthographic view of coleus harvester (All dimensions are in mm)

Load:

Load was measured using a load cell connected with the tyne of the harvester. The load cell measured the tensile load acted on the tyne and the load was measured in kilogram force. It was then converted into Kilo Newton.

Effective field capacity:

For determining the effective field capacity, the actual time elapsed was noted. The time lost for other activities such as turning, loading, unloading and other adjustments were noted depending on field conditions and the field capacity is calculated as the ratio of actual area covered (ha) to the time taken in hours.

Harvesting efficiency:

The harvesting efficiency is defined as the ratio of actual weight of rhizomes harvested per unit area to the total weight of unearthed rhizomes collected from the area. It is expressed in percentage.

Damage percentage:

The percentage of the damaged or cut rhizomes in the harvested crop was determined by sampling 50 rhizomes at random and counting the number of damaged or cut rhizomes. The percentage of damaged rhizomes is calculated as the ratio of weight of damaged rhizomes to the weight of total rhizome harvested, expressed in percentage.

Economic analysis:

The labour requirement for conventional and mechanical harvesting along with the reduction in wages for mechanical harvesting was calculated. Cost of harvesting operation of coleus using the harvester was estimated.

■ RESULTS AND DISCUSSION

The field tests were conducted to evaluate the performance and economics of the developed coleus harvester. The harvester was field tested with three different tynes for its field capacity, harvesting efficiency, fuel consumption, load and damage of rhizomes.

The load and specific fuel consumption:

Fuel consumption for field operation varied according to the load of the implement. Among three different tynes, the load and the specific fuel consumption was minimum for cylindrical tyne at 7 cm depth and the maximum was found in flat tynes at a depth of 11 cm. The load and specific fuel consumption of coleus harvester varied with the tynes at different depths of operation and is presented in the Table 1.

Table 1 : Fuel consumption and loads at different depths of operation of different tynes

Type of tyne	Depth of operation (cm)	Specific fuel consumption ($kg.kw^{-1}h^{-1}$)	Penetrating load (kN)
Cylindrical	7	0.296	0.268
tyne	9	0.307	0.350
	11	0.309	0.433
Angular tyne	7	0.347	0.816
	9	0.357	0.964
	11	0.360	1.261
Flat tyne	7	0.358	0.742
	9	0.365	1.038
	11	0.368	1.187

The variation of specific fuel consumption and effective penetrating loads for the three different tynes at different depths of operation are illustrated in Fig. 1. The three different points of each line in the Fig. 1 represent the depth of operation (7cm, 9 cm, and 11cm).

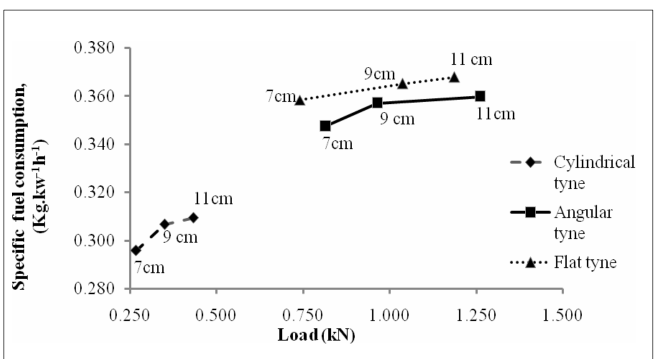


Fig. 1 : Specific fuel consumption and loads at different depths of operation

The results revealed that as the depth of operation increased, the fuel consumption and load increased. This may be due to the effect of additional load to the engine caused by more penetrating loads.

Variation of operating speed in field operation:

The operating speed was noted for different operational depths for three set of tynes and the results are given in Table 2 for coleus.

Table 2 : Operating speed of harvester in coleus field

Type of tyne	Depth of cut (cm)	Cutting speed ($m.sec^{-1}$)
Flat	7	0.152
	9	0.147
	11	0.145
Angular	7	0.175
	9	0.161
	11	0.156
Cylindrical	7	0.224
	9	0.211
	11	0.202

The statistical analysis (Table 3) showed that there was significant difference in operating speed with the type of tyne and depth of operation. The combination of type of tyne and operating depth had no significant effect at 5 per cent level of significance.

Table 3 : Analysis of variance on operating speed with different tynes at different operating depths

Source	d.f.	M.S.	F-ratio	$(CD)_{0.05}$	C.V.
Reps.	2	0.94	2.48		
Type of tyne(A)	2	36.44	95.98	0.6155	
Depth of operation (B)	2	2.166	5.70	0.6155	
AB	4	0.167	0.44	NS	
Error	16	0.380			5.88%

NS=Non-significant

Effective field capacity:

The effective field capacity was determined for three types of tynes in three different plots each in an area of $40m^2$. The effective field capacities obtained for coleus harvester is presented in the Table 4.

Table 4 : Average effective field capacity of the harvester field operation

Type of tyne	Area harvested (m^2)	Time taken (sec.)	Effective field capacity ($ha.h^{-1}$)
Flat	40	263	0.0532
Angular	40	236	0.0591
Cylindrical	40	188	0.0764

The results indicated that the effective field capacity of harvester with cylindrical tyne was more than that with flat and angular tynes. The effective field capacity of angular tyne and flat tynes were found closer to each other as compared with the other tyne.

Harvesting efficiency:

The harvesting efficiency of each tyne at different depths of cut was calculated. The weight of the rhizomes uprooted and non-uprooted with three sets of tyne are presented in Table 5.

Table 5 : Harvesting efficiencies with different types of tynes

Type of tyne	Depth of cut (cm)	Weight of rhizomes uprooted (g)	Weight of rhizomes not uprooted (g)	Harvesting efficiency (%)
Flat	7	402	170	70.28
	9	384	145	72.59
	11	379	155	70.97
Angular	7	439	123	78.11
	9	455	114	79.96
	11	395	98	80.12
Cylindrical	7	426	221	65.84
	9	415	206	66.83
	11	388	192	66.90

The statistical analysis showed that the harvesting efficiency was more in the case of angular tynes. Maximum harvesting efficiency was found at a depth of 11 cm in angular tynes (Table 6).

Table 6 : Analysis of variance on harvesting efficiency with different tynes and operating depths

Sources	d.f.	M.S.	F ratio	$(CD)_{0.05}$	C.V.
Reps.	2	10.27	2.13		
Type of tyne (A)	2	381.51	79.06	2.194	
Depth of operation(B)	2	7.06	1.46	NS	
AB	4	0.97	0.20	NS	
Error	16	4.83			3.03%

NS=Non-significant

Damaged rhizomes in field operation:

The percentage of damaged rhizomes harvested is illustrated in Fig. 2. From the results, it was observed that the percentage damage of rhizome was very less in the case of cylindrical tyne compared with the other two types of tyne.

Conclusion:

A self propelled coleus harvester was developed for easy uprooting of the rhizomes. It consists of a propelling and harvesting units, three types of tynes, respectively as flat, cylindrical, and angular tynes and were field tested. It is concluded that with the increase of depth of operation, the load and the fuel consumption increased. The load and fuel consumption were found maximum with flat tynes and minimum with cylindrical tynes. Statistical analysis showed that the depth of operation has significant effect on cutting speed. The maximum effective field capacity of the harvester was found to be 0.0764 ha h^{-1} with cylindrical tynes. The harvesting unit with angular tyne has maximum harvesting efficiency of 80.12 per cent. Damage percentage was lower in the case of cylindrical tyne compared to angular and flat type tynes.

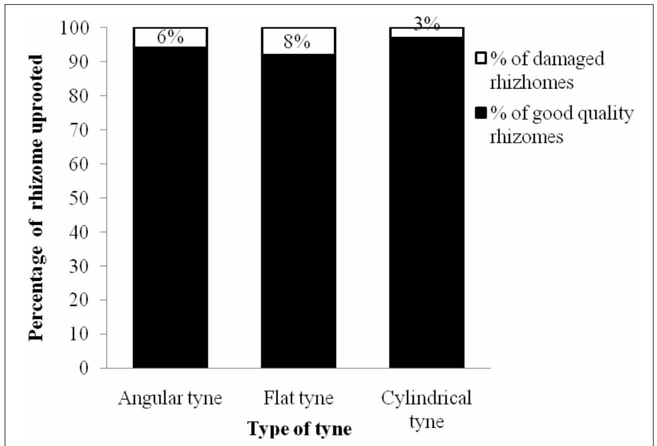


Fig. 2 : Percentage of rhizomes harvested with different types of tynes

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REFERENCES

Fathollahzadeh, H., Mobli, H., Rajabipour, A., Minaee, S., Jafari, A. and Tabatabaie, S.M.H. (2010). Average and instantaneous fuel consumption of Iranian conventional tractor with mould board plough in tillage. *ARPN J. Engg. & Appl. Sci.*, **5**(2): pp: 30-35.

Kerala Agricultural University (1999). Package of practices recommendations of crops. Directorate of Extension, Mannuthy. pp: 103-105, 150-151.

Peter, K.V. (2007). *Underutilized and underexploited horticultural crops.* New India Publishing Agency, New Delhi (India), pp. 29-36.

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