International Journal Of Advancement In Engineering Technology, Management and Applied Science (IJAETMAS)
ISSN: 2349-3224 || www.ijaetmas.com || Volume 03 - Issue 07 || July 2016 || PP. 16-19

Modification and testing of a coleus harvester

Er.YOUNUS.A[1] and **P.R.JAYAN** [2]
[1]*Test Engineer, FMTC, Kelappaji College of Agricultural engineering and Technology, Tavanur, Kerala, India*
[2]*Professor, Kelappaji College of Agricultural engineering and Technology, Tavanur, Kerala, India*

ABSTRACT:

Coleus (Solenostemonrotundifolius) commonly known as Chinese potato, is a major tuber crop of Kerala, raised purely as a rain fed crop from June to December. It is usually planted during May-June every year on raised beds at a spacing of 15 x 15 cm at a depth of 5 to 10 cm. Manual harvesting of coleus is done by using spade and forks, which is very tedious and time consuming operation, requires proper handling, devoid of cuts, breakage, bruises and injuries. To overcome these problems and decreasing the cost of harvesting operation, a self propelled coleus harvester further modified and field tested. The developed coleus harvester was an attachment to a mini tiller. It consists of a prime mover, a cutter bar, rotary blade, and driven wheels. As and when tiller move, the cutter bar pierced into the soil at a depth of 1-15 cm and at an angle of 40o to digout the rhizomes that lie inside the soil. The uprooted coleus coming over the inclined tynes of cutter bar were then pushed out by means of the rotary splasher rotating just above the cutter bar. The scattered coleus lying in the seedbed collected easily and hence the harvesting becomes easier and faster. The rotary slasher are the rotating blades attached to the rear side of the tiller was modified in such a way that they were removed and rubber flaps of 75 x 75 x 0.3 mm were fastened to the shank of the rotary blade. Thus the rubber flaps fastened at the position of the tynes. On rotation, it pushes dugout coleus outward without any injury. A set of larger wheels were designed and fabricated separately with diameter of 80 cm.

The performance of the modified coleus harvester was compared with respect to time, fuel consumption, weight and percentage of damage of coleus separately with flat and angular tynes. The experiments were laid out according to Factorial Randomized Block Design (FRBD) and were statistically analyzed using three factor ANOVA using MSTAT. The performance on time taken (s) to dig out coleus with 6-tyne and 10 - tyne flat and angular cutter bar fitted with the harvester revealed that the time taken was the highest in beds of 70 x 30 cm, whereas minimum time taken was in the bed size of 50 x 30 cm. The fuel consumption (ml) for harvesting was the highest in the bed size of 70 x 30 cm and minimum was in the bed size of 50 x 40 cm while using 6 tynes. When operated with 10 tynes, it is noted that the fuel consumed was the highest in beds of 70 x 20 cm, whereas minimum fuel consumption was in the bed size of 50 x 20 cm. The weight (kg) of coleus was the highest in beds of 70 x 30 cm, whereas minimum weight obtained was in the bed size of 50 x 40 cm while using 6 tynes. If 10 tynes are used it is noted that the weight (kg) of coleus was the highest in beds of 70 x 20 cm, whereas minimum weight obtained was in the bed size of 50 x 20 cm. It was also observed that the percentage of damage of coleus was the highest in beds of 70 x 30 cm, whereas minimum damage was occured in the bed size of 70 x 40 cm while using 6 tynes.

The field capacity of the modified coleus harvester is 0.057 ha.h^{-1}. At the present wage rate of Rs 500 per day, the total cost of operation by manual method is about Rs 31,250 per ha. Where as harvesting by the harvester, the total cost of operation is Rs 7680 per ha. Hence the savings over conventional method is Rs 24,470 per ha. The field efficiency of the harvester was calculated as 91%.

I. INTRODUCTION

Coleus (*Solenostemonrotundifolius*) commonly known as Chinese potato, is a major tuber crop of our State. It is grown in most of the homestead gardens of Thrissur, Palakkad and Malappuram districts. It grows well in warm humid climate and in drained medium fertile soils. It is raised purely as a rain fed crop in the State from June to December. The first step in coleus cultivation is preparation of nursery, which is usually done during May-June every year. It is planted on raised beds at a spacing of 15 x 15 cm at a depth of 5 to 10 cm. Harvesting is done when haulms dry up, i.e., 4 to 6 months after planting. Using spade and forks, the tubers are taken out from the soil. Manual harvesting of coleus is very tedious and time consuming operation which requires proper handling, devoid of cuts, breakage, bruises and injuries. To overcome these problems and decreasing the cost of harvesting operation, a self propelled coleus harvester was developed in the College, which was further modified and field tested under this project. The irregular geometry of tubers, different maturity stages and soil conditions were the major constraints in its modification. Hence a research work was

carried out to modify the developed harvester to dig out the coleus with specific objectives to minimize time, fuel consumption and damage.

II. MATERILS AND METHODS

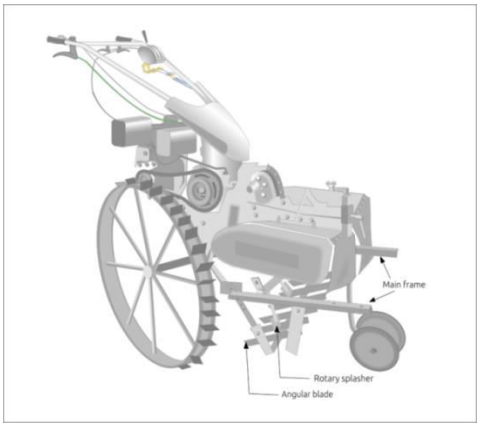
An area of 0.128 ha in D-Block of Regional Agricultural Research Station (RARS), Pattambi was selected as study area, which is situated at a 10.8200° N latitude and 76.2000° E longitude. The site has good drainage and sunlight without any shade. The soil of the selected field was sandy loam with moisture content 30 per cent. The physical properties of the soil affect directly or indirectly at the soil-tool interface as well as the growth of the crop. The major three properties, viz, moisture content, bulk density and penetration resistance of the soil were determined. Soil samples were taken from each of the study area for soil moisture content determination at depths of 0-5, 5-10, 10-15,15-20,20-25 and 25-30 cm, but bulk density were determined at depths of 0-20,20-30and 20-40 cm after ploughing. A soil auger was used to take soil samples for moisture content determination, whereas a soil core cutter of size 6.5cm and 10cm in diameter and a rammer was used to take soil sample for bulk density determination. Soil samples were oven dried at a temperature of 105^{o}C for 24 hours in accordance with the gravimetric soil moisture determination method. In situ tests were carried out at depths of 0-10, 10-20, 20-30 and 30-40 cm for each study area at harvest to determine the soil penetration resistance at known soil depths and using soil cone penetrometer.

The field lay out was made in such a way that it was divided into two equal plots of 0.06 ha. In each plot, beds of sizes 10 m x 0.5 m and 10 m x 0.7 m respectively as length x breadth were prepared. Good quality cuttings of 'Nidhi' variety of coleus were selected for planting. It was planted at a depth of 10.0cm with spacing of 15 cm x 15 cm in each bed; hence the total number of cuttings per bed was 189. Channels of 0.3 m x 0.3 m were made around each lot to provide proper drainage. The planting was done during July first week of 2014, i.e, after getting enough rainfall during South West monsoon.

The physical and mechanical properties of the coleus viz., size, shape, sphericity, weight and toughness and firmness were found out using standard test procedures. The size of the coleus was determined by using Vernier calipers and that of the shape by graphical method. The firmness and toughness of the coleus were determined using texture analyzer.

Manual harvesting of coleus

The developed coleus harvester was an attachment to a mini tiller. It consists of a prime mover, a cutter bar, rotary blade, and driven wheels. The prime mover is a 3.5 hp 2- stroke diesel engine. The use of such a tiller proved to be advantageous for wide variety of reasons like the compactness, small size, easy movement on narrow terrains, and ease of operation for women, smooth mobility and also a 360^{o} turning facility of handle. Its main frame accommodates all the attachments and accessories of the harvester. It holds the cutter bar assembly and is bolted to chassis of mini tiller. The tynes fitted to the cutter bar is the penetrating part of the equipment. It takes most of the soil resistance during operation. The two sets of cutter bar with flat and angular tynes were made for comparing the performance of the harvester. The flat tynes were made ofand MS square 300 mm x 20 mm x 20 mm and angular tynes were made of MS angle 300 mm x 5 mm x 25 mm. The ends of square pipes were provided with a slight bending for better penetration and earthing up of coleus from soil. The tynes are positioned in such a way that they make an angle of 40^{o} with the vertical. This helps in easy penetration into the soil with respect to various tyne, provisions were made to adjust the penetrating angles for better performance.



Modified coleus harvester

Testing of modified coleus harvester

The rotary slasher are the rotating blades attached to the rear side of the tiller. The drive to which is transferred through chain sprocket assembly from the engine. In order to modify the harvesting unit, the rotary blades (L-shaped tynes) were removed and rubber flaps of 75 x 75 x 0.3 mm were fastened to the shank of the rotary blade. Thus the rubber flaps fastened tynes (rotary splasher) on rotation will splashes or pushes away the dugout coleus outward simultaneously. The wheels of tillers are act as vehicle traction elements to generate enough tractive force to overcome soil resistance and to ensure resistive forced motion. The wheel provided by the manufacturer was lesser in diameter and with low maneurability. Hence a set of larger wheels were fabricated separately with diameter of 80 cm using in MS flat of 50 mm x 3 mm and square rod of 10 mm x 10 mm to operate the harvester at various heights of seed beds.As and when tiller move, the cutter bar pierced into the soil at a depth of 1-15 cm and at an angle of 40^{o} to dig out the rhizomes that lie inside the soil. The uprooted coleus coming over the inclined tynes of cutter bar were then pushed out by means of the rotary splasher rotating just above the cutter bar. The scattered coleus lying in the seedbed collected easily and hence the harvesting becomes easier and faster. Rubber mudguard is provided to protect the operator from scattered stones or debris which may be thrown away as projectile along with coleus.

III. RESULTS AND DISCUSSION

Trials were conducted in beds having width x height as (50 x 20), (50 x 30), (50 x 40), (70 x 20), (70 x 30) and (70 x 40) cm for each bed length of 10 m. In each bed, performance evaluation of the harvester with 6 and 10 number of flat and angular tyne cutter bars with different was carried out for each of the treatment combinations. The bed widths selected for the study were 50 and 70 cm and the bed heights selected were 20, 30 and 40 cm. Three replications were carried out to each trial. The total number of treatments was 72. The observations were statistically analyzed using three factor ANOVA using MSTAT. The experiments were laid out according to Factorial Randomized Block Design (FRBD).

The performance of the modified coleus harvester was compared with respect to time, fuel consumption, weight and percentage of damage of coleus separately with flat and angular tynes. The observations were separately recorded for various bed sizes of 50 x 20, 50 x 30, 50 x 40, 70 x 20, 70 x 30, and 70 x 40 cm respectively as bed width x bed height with respect to 6 and 10 tynes flat and angular tyne cutter bar per 10 m length of beds. The results were compared with respect to time, fuel consumption, weight and percentage of damage.

The performance on time taken (s) to dig out coleus with 6- tyne and 10 - tyne flat and angular cutter bar fitted with the harvester revealed that the time taken was the highest in beds of 70 x 30 cm, whereas minimum time taken was in the bed size of 50 x 30 cm.

The fuel consumption (ml) for harvesting was the highest in the bed size of 70 x 30 cm and minimum was in the bed size of 50 x 40 cm while using 6 tynes. When operated with 10 tynes, it is noted that the fuel consumed was the highest in beds of 70 x 20 cm, whereas minimum fuel consumption was in the bed size of 50 x 20 cm. The weight (kg) of coleus was the highest in beds of 70 x 30 cm, whereas minimum weight obtained was in the bed size of 50 x 40 cm while using 6 tynes . If 10 tynes are used it is noted that the weight (kg) of coleus was the highest in beds of 70 x 20 cm, whereas minimum weight obtained was in the bed size of 50 x 20 cm.

It was also observed that the percentage of damage of coleus was the highest in beds of 70 x 30 cm, whereas minimum damage was occured in the bed size of 70 x 40 cm while using 6 tynes . If 10 tynes are used it is noted that the damage of coleus was the highest in beds of 70 x 20 cm, whereas minimum damage was in the bed size of 50 x 20 cm.

Performance analysis of a commercial harvester (TNAU ginger harvester) indicated that the vibrating mechanism provided was useful to obtain the coleus in clumps after harvest. In field operation it was not possible for uprooting coleus in the bed sizes of 50 x 40 cm and 70 x 40cm. The major draw backs observed with this harvester were its low ground clearance and non detachment of the clumps hence it cannot be used for beds having more than 30 cm as it is the common practice among coleus farmers of the State. The separation of coleus after harvest is yet another difficulty in operating with such commercial model. Hence the harvester is to be further modified to suit the bed sizes having more than 30 cm height.

IV. CONCLUSION

The field capacity of the modified coleus harvester is 0.057 $ha.h^{-1}$. Coleus harvesting by manual method requires 148 man hours per ha. At the present wage rate of Rs 500 per day, the total cost of operation by manual method is about Rs 31,250 per ha. By mechanical harvesting the total cost of operation is Rs 7680 per ha. Hence the savings over conventional method is Rs 24,470 per ha. The field efficiency of the harvester was calculated as 91%.

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