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WEAR CHARACTRITICS OF COMMERCIALLY AVALABLE TRACTOR DRAWN CULTIVATOR SWEEPS IN ABRASIVE SAND

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Abstract: Wear of soil engaging components occurs because the materials used are normally softer than the natural abrasives in the soil. Most of sweeps of cultivator are manufactured locally which are hardly as per with the standards which affects operational life of tillage tool. So, there was a need to study wear characteristics of sweeps so as to provide the suitable sweeps. Study was conducted in rotary soil bin in abrasive sand. Sweeps of three different makes were tested at speed 1 $m \cdot s^{-1}$ and depth100 mm respectively. After running the sweeps for 20 h in the soil bin, sweeps were weighted and loss in weight and dimensional wear loss was noted down. Similar procedure was followed for 100 h time intervals. It was observed that the weight of sweeps decreased linearly with increase in working period for all the tested sweeps. The maximum cumulative wear was observed for sweep S_2 (18.25 gm) followed by sweep S_1 (15.4 gm) and sweep S_3 (13.8 gm). The maximum cumulative tip wear was observed for sweep S_2 (1.78 mm) followed by sweep S_1 (1.48 mm) and sweep S_3 (1.31 mm) and maximum cumulative edge wear was observed for sweep S_2 (1.20 mm) followed by sweep S_1 (0.96 mm) and sweep S_3 (0.84 mm) when operated for 100 h. The sweep S_3 was found best in this study which has minimum gravimetric wear, tip wear and wing wear.

Key words: *sweeps, soil bin, abrasive sand, wear*

INTRODUCTION

Agriculture in India is unique in its characteristics about 250 different crops cultivated in different agro climatic zones. It is one of the most important sector of

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Indian economy, contributing to 18.5% of national income; about 15% of total export and supporting two third of the work force. Agricultural engineering inputs have played an important role in increasing production through appropriate mechanization [8]. At present in India tractors are being used for tillage and sowing of 22.78% and 21.30% of total area [5]. Cultivator is one of the most important tillage tools used by Indian farmer. Even many organic farmers say that a pass with the cultivator has the same effect on the crop in dry weather as a half inch of rain It is primarily, the type of tillage implement which is used for opening the land, preparing the seedbed for sowing of the seeds as well as after the crop has come up a few cm above the ground [3]. The field cultivators are about often used as secondary tillage tools for seedbed preparation.

The small scale industries are manufacturing tillage tools like ploughs, cultivators, harrows, etc in large quantities which are being used on large scale among farmers. These parts are subjected to wear due to friction. In agricultural machines, wear is the most rapid and common form of damage, this is responsible for most of the idle time and maintenance, apart from heavy expenditure on repair and spare parts. The wear in agricultural machinery is basically abrasive in nature because such tools usually come in contact with the soils which are abrasive due to quartz, stone and sand contents etc. abrasive wear means removal or displacement of material from solid metallic surface due to pressure exerted by continuous sliding of hard soil particles.

It has been observed that a large number of sweeps shovels wear out sometimes in one season only. This results in high maintenance cost, frequent stoppage of work and loss of time during peak hours till replacement. It is also well established that a blunt sweep requires draught comparatively on higher side and therefore it increases the cost of field operations. The quality of work is affected adversely and a large amount of energy is wasted by continuous use of blunt sweeps.

Keeping this was view the study is planned to find suitable sweep for farm operation to improve performance. In view of the above, the present study was undertaken in accelerated wear test set up on cultivator shovels with the following objective: To study the wear loses of different commercially available sweeps in abrasive sand.

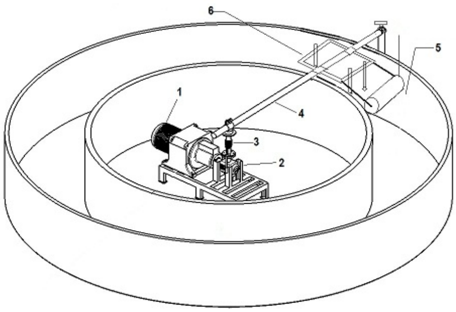
MATERIAL AND METHODS

Experimental Set-up

The experimental set-up comprised of an indoor circular soil bin, a power transmission unit, control panel, tool frame and a soil compaction unit. A schematic diagram of the experimental set up is shown in Fig. 1.

Plan of Work

The experiments were conducted in indoor circular soil bin for selection of commercially available sweep which has low wear characteristics. The research plan for is explained below. Hardness test of sweeps were conducted for the available sweeps using Rockwell hardness tester.



1.D.C Motor 2. Gear box 3.Verticle shaft 4. Horizantle shaft
5.Soil bin 6. Tool frame 7. Compaction roller

Figure 1.Isometric view of experimental set up

Table 1. Different levels of parameters considered in the study of this experiment

	Independent parameters	Levels	Values	Dependent parameter
1	Sweeps	3	S_1, S_2, S_3	1. Gravimetric wear (gm) 2.Dimentional wear (mm)
2	Operating hours	5	20,40,60,80,100 h	
3	Speed of operation	1	1 $m \cdot s^{-1}$	
4	Depth of operation	1	10 cm	

Test procedure

For this study the soil bin was filled with abrasive sand up to the height of 800 mm. The height of sand was maintained uniform in the soil bin. Commercially available sweeps (Fig. 2) were mounted on the shanks and were set to operate at a depth of 100 mm from the top surface of the sand.

Figure 2.Different commercially available sweeps used for experiments

The tool carriage was rotated at a peripheral speed of 1 $m \cdot s^{-1}$ [1]. The wear tests were conducted for 100 hours and gravimetric and dimensional wear were measured at a regular interval of 20 hours. At the end of each interval, the sweeps were detached from shanks and thoroughly washed in water before measurement. The gravimetric wear losses of sweeps were determined by taking the difference in weight of sweeps before and after the operation. The reduction in dimensions with respect to tip length (the distance from the bolt hole to the tip), edge length (the minimum distance from the bolt hole to the cutting edge on the wing) [2] was measured with digital vernier caliper (LC 0.1 mm) (Fig. 3). Three replications were taken for each sweep. The worn out sweeps after 100 h of operations are shown in Fig. 4.

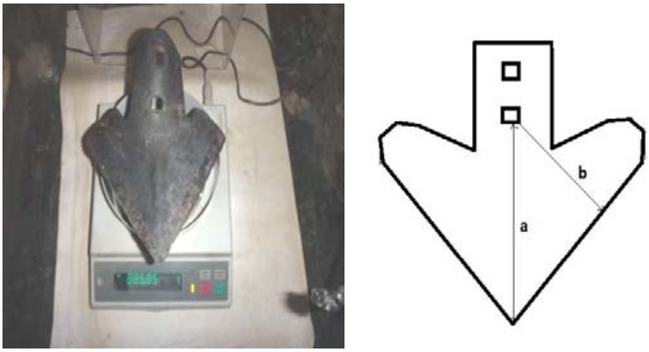


Figure 3. Measurement of gravimetric and dimensional wear

Figure 4. Different commercially available sweeps after operation in sand for 100 h

RESULTS AND DISCUSSION

Gravimetric wear

In this study, the gravimetric wear of different commercially available sweeps of tractor drawn cultivator was observed and is discussed as under.

Effect of working period

The relationship between gravimetric wear and time is shown in Fig. 5. It is clear from the Fig. 5 that the weight of sweeps decreased linearly with increase in working period for all the tested sweeps. The maximum cumulative wear was observed for sweep

S_2 (18.25 gm) followed by sweep S_1 (15.4 gm) and sweep S_3 (13.8 gm) when operated for 100 h. These results are similar to findings of [4] and [5] who also reported a linear relationship between cumulative wear and period of work. It was interesting to note that higher average wear rate of 0.17 $gm \cdot h^{-1}$ was observed during first 40 h of operation and the same reduced to 0.14 $gm \cdot h^{-1}$ in the next 60 h of operation for all three sweeps. This may be due to oxide coating of sweep which might have worn out at initial 40 h. This may result in more corrosion of sweep after 40 h use.

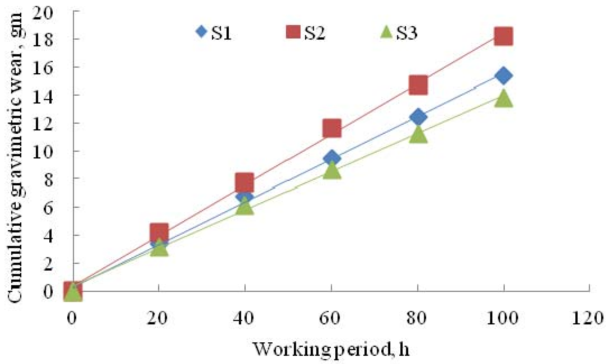


Figure 5. Relationship between cumulative gravimetric wear and working period of different sweeps

Dimensional Wear

Dimensional wear loss was measured at two points of the sweeps as explained in the previous section. The cumulative wear loss in tip and edge of sweeps S_1, S_2, S_3 were recorded for 100 h at an interval of 20 h.

Effect of working Period on tip wear

It is clear from the Fig. 6 that cumulative wear of tip increases linearly with increase in working period for all the tested sweeps.

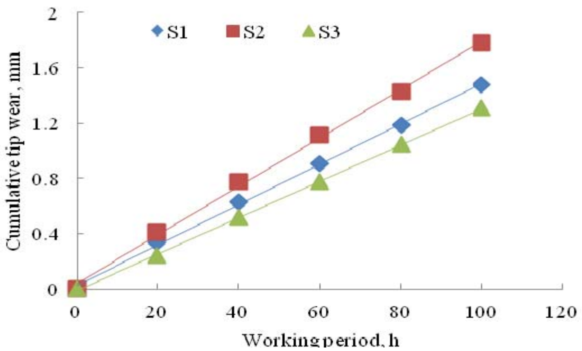


Figure 6. Relationship between cumulative tip wear and working period of different sweeps

The maximum cumulative tip wear was observed for sweep S_2 (1.78 mm) followed by sweep S_1 (1.48 mm) and sweep S_3 (1.31 mm) when operated for 100 h. These results are similar to findings of [2]. A higher average wear rate of 0.018 $mm{\cdot}h^{-1}$ was observed during first 20 h of operation and the wear rate reduced to 0.015 $mm{\cdot}h^{-1}$ in the next 80 h of operation for sweepsS_1 and S_2. Sweep S_3 worn out at higher rate of 0.02 $mm{\cdot}h^{-1}$ during first 40 h of operation and the wear rate reduced to 0.012 $mm{\cdot}h^{-1}$ in the next 60 h. This may be due thin section of sweep at the tip which might have worn out at initial 20 h and 40 h.

Effect of working period on edge wear

It is clear from the Fig. 7 that wear of edge increases linearly with increase in working period for all the tested sweeps.

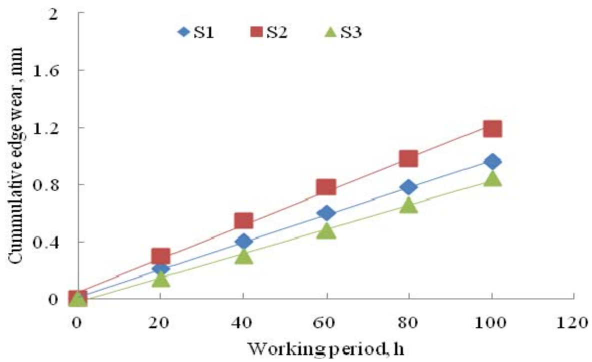


Figure 7.Relationship between cumulative edge wear and working period of different sweeps

The maximum cumulative edge wear was observed for sweep S_2 (1.20 mm) followed by sweep S_1 (0.96 mm) and sweep S_3 (0.84 mm) when operated for 100 h. These results are similar to findings of [2].The higher average wear rate of 0.011 $mm{\cdot}h^{-1}$ was observed during first 20 h of operation and same reduced to 0.009 mm/h in the next 80 h of operation for all three sweeps. This may be due to oxide coating of sweep which may wear out at initial 40 h. The minimum edge wear was found in S_3 at each interval of 20 h when operated for 100 h . This may be due to maximum hardness of sweep S_3.

CONCLUSIONS

It is observed that that the weight of sweeps decreased linearly with increase in working period for all the tested sweeps. The maximum cumulative wear was observed for sweep S_2 (18.25 gm) followed by sweep S_1 (15.4 gm) and sweep S_3 (13.8 gm) when operated for 100 h. The cumulative wear loss in tip and wing of sweeps $S_{1,}$ $S_{2,}$ S_3 was recorded for 100 h at an interval of 20 h. The maximum cumulative tip wear was observed for sweep S_2 (1.78 mm) followed by sweep S_1 (1.48 mm) and sweep S_3 (1.31 mm) when operated for 100. The maximum cumulative edge wear was observed for sweep S_2 (1.20 mm) followed by sweep S_1 (0.96 mm) and sweep S_3 (0.84 mm) when operated for 100 h. The sweep S_3 was found best in this study which has minimum gravimetric wear, tip wear and wing wear.

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KARAKTERISTIKE HABANJA MOTIČICA VUČENOG KULTIVATORA U ABRAZIVNOM PESKU

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Sažetak: Radni organi se troše u didru sa zemljištem jer su materijali od kojih su izrađeni uobičajeno mekši od prirodnih abraziva u zemljištu. Većina kultivatorskih motičica su izrađene u lokalnim radionicama, i retko odgovaraju standardima koji se odnose na radni vek radnog organa za obradu zemljišta. Zato je bilo potrebno ispitati karakteristike habanja motičica dostupnih na tržištu, kako bi se izdvojile one koje odgovaraju standardima. Ispitivanje je izvedeno u kružnom zemljišnom bazenu sa abrazivnim peskom. Motičice tri različita proizvođača ispitivane su pri brzini rada od 1 $m \cdot s^{-1}$ i na dubini od 100 mm. Posle rada u trajanju od 20 h u zemljanom bazenu, motičice su merene da bi se dobili gubitak mase i smanjenja dimenzija zbog habanja. Sličan postupak je ponovljen i posle 100 časova rada. Utvrđeno je da se masa motičica smanjuje linearno sa povećanjem radnog perioda kod svih ispitivanih modela.

Maksimalno kumulativno habanje ustanovljeno je kod motičice S_2 (18.25 g), zatim kod motičice S_1 (15.4 g) i najmanje kod modela S_3 (13.8 g). Maksimalno kumulativno smanjenje dimenzija dobijeno je kod modela S_2 (1.78 mm), zatim kod motičice S_1 (1.48mm) i najmanje kod modela S_3 (1.31 mm), a maksimalno kumulativno habanje ivica bilo je dobijeno kod motičice S_2 (1.20 mm), zatim kod motičice S_1 (0.96 mm) i najmanje kod modela S_3 (0.84 mm), posle 100 časova rada. Zaključeno je da je motičica S_3 pokazala najbolje rezultate u ovom ispitivanju, sa najmanjim habanjem po svim merenim kriterijumima.

Ključne reči: *motičice, zemljani bazen, abrazivni pesak, habanje*

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