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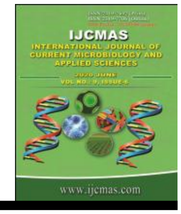

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Analysis of Wear Characterization on Various Make of Agricultural Discs

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A B S T R A C T

Wear of working tools is one of the major problems when machining soil masses. The process consists of many factors, including the item of work, the properties of the soil and the parameters of the working process. A plain carbon steel is the most common commodity currently used in metallurgical mining and the agricultural industries in India. Especially mild steel is usually used for the manufacture of agricultural equipment and critical parts in agricultural machinery industries and is therefore wearing fast under high load and abrasive conditions. Wear is the main reason for the loss of performance of the parts for agricultural machinery. It leads to the degradation of the soil working quality. This work aims to highlight the wear resistance agricultural disc of the harrows discs manufactured, consolidated and sharpened differently. The tests were conducted in the field in G.B.P.U.A&T. Pantnagar, Uttarakhand and for measurement the gravimetric wear of agricultural discs made of different materials. Experiments were conducted on the Agricultural disc in order to find out the effect of different operating time on weight reduction in field condition moisture content of about 12-14 per cent (dry basis), depth of operation 10 cm and speed of operation 4.5 km/h at working period of 100 hours. Four types of make of disc used in this study were T1(36.3), T2(38.1), T3(41.5) and T4(42.1) agricultural disc hardness respectively. The average maximum weight losses were 1004.75, 848.86, 705.74 and 549.88 g for T1(36.3), T2(38.1), T3(41.5) and T4(42.1) respectively. The effect of working time and wear loss in weight of the agricultural disc on materials T1 to T4 respectively was found to be significant at 1 per cent level of significance.

Introduction

Wear subject is of immeasurable economic value, because it is the factor that typically decides the useful life of the most farm implements and machinery. From the very beginning, important problems have been the production and adaptation of good quality materials for making cutting edges and soil-working surfaces of tillage devices. The cost of repairing the components for tillage implements was calculated to be about 8 million pounds per year in the United Kingdom (Moore, 1975), as well as the labor costs and replacement costs of these damaged parts was about 1.5 million pounds per year.

Additionally, inconvenience in work plans impacts schedules, specifically throughout seeding operations and energy consumption also increases with wear. Karamis (1987) recorded that within a year 9, 701, 850 kg of steel was lost due to wear in Turkish agricultural fields on the assumption that

13,422,000 ha of cereal land was planted approximately twice and cultivated once. The energy equivalent of this wear was calculated. A total of 841.15106 MJ of energy had been found to be wasted. Agricultural production in India is different in its characteristics. About 250 different crops are grown in different agro-climate zones. This is one of Indian economy's most important industry, adding up to 18.5 per cent to economic output, around 15 per cent of total exports, and employing two-thirds of the workforce.

Inputs from agricultural engineering played a significant role in increasing productivity by means of effective industrialization (Manchikanti and Sengupta, 2011). Due to its timeliness of activity, quality of work and the ability to save resources, the requirement of power for certain operations such as seedbed planning, cultivation and harvesting becomes so high that the current animal and human power becomes insufficient. Tillage is also the most significant unit in agriculture which requires a high amount of energy. It is primarily done for loosening the soil, mixing it with fertilizer and eliminating weeds. As a consequence of this treatment the soil's water, air, thermal and nutrient conditions are developed in the direction of crop development and growth. The most commonly known way of tilling land is to plough with moldboard plough. Moldboard plough inverts the upper soil layer in this ploughing process, without appropriate soil mixing.

Therefore, additional operations, such as rotavator and harrowing etc., are needed to improve the ploughing tilth of soil. The moldboard plough, disk plough, and cultivators experience significant difficulties if abrasion conditions are too extreme for ground-engaging devices, or when the maintenance costs of equipment involve more regular maintenance of components. Nevertheless, studies on wear of the blade as well as wear resistance of various surface treatments are scarce, since wear is the most important factor in predicting a blade's service life. Hence there is a need to carefully research these aspects. Disc harrows are commonly used in modern sustainable and organic crop production, in particular for the so-called compact harrow version (Kogut, 2011a; Talarczyk, 2004; Talarczyk and Zbytek, 2006). Today every machine or machine part faces wear problems in industry and it also affects society economically.

In addition, wear is one of the major issues in the mineral processing industry and can be seen in various parts, equipment and machine parts. Specifically, in tools that engage on the field, typically in agricultural equipment, high wear rates of ground-engaging tools cause enormous material mutilation, periodic work, downtime and maintenance costs of worn-out parts. It also affects lifespan of the tool due to loss of the tool's material (Bayhan, 2006). The wear cycle is not only countable for material removal but also contributes to early engineering device failure. Therefore, the present study was undertaken to select the appropriate agricultural disc for disc harrow by using a well simulated methodology for inducing wear resistance of all steels to enhance their life.

Materials and Methods

The combine harvested rice field at Seed Production Research Centre of the University was selected to conduct the experiment to assess the performance of the disc of were fitted on a tractor mounted disc harrow in the field test. The disc harrow had 7*7-disc harrow. Four make of agricultural disc were used with different hardness *i.e.* 36.3, 38.1, 41.5 and 42.1 HRC. Diameter of each disc 610 mm. Disc harrow disc used in the study was made from high carbon steel (EN-42) with a composition given in Table 1. The soil of the test field is silt clay loam having different constituents as sand (14.80%), silt (55%) and clay (30.20%) were calculated by biophas method. The pH of soil as 7.02 as measured by digital pH meter and Organic Carbon percentage was 1.02. The field was free from weeds except rice residues. The height of stubble was 270 mm. the initial bulk density and moisture content of test plot were 1.52 g/cc and 14% respectively. The average cone index of soil was .89 kg/cm^2 at depth of 100 mm. actual field capacity 0.459 ha/h, theoretical field capacity 0.688 ha/h and field efficiency 0.667 covered by harrow 0.78 ha/h.

The gravimetric wear was measured by an electronic weighing machine Prior to starting the experiment, the weight of all discs was taken. The electronic balance had a weighing capacity of 40,000 g with least count of 0.01g. After each 20 h interval of working, the discs were taken out from the tool carriage, washed in clean water and again cleaned in dilute acetone solution and, then weighed using the electronic balance. The weight difference between initial weight and final weight for total 100 h of operation gave wear. During the experiment period, the data of weight loss at successive interval of 20h were noted to see the wearing pattern of the discs. The percentage of weight loss was measured using the equation 1.

$$\%\ \text{Weight Reduction} = \frac{W_i - W_t}{W_i} \times 100 \quad \text{......Eq.1}$$

Where, W_i = Initial weight of disc,

W_t = Weight of disc after time, t

Results and Discussion

On the basis of confined field tests of different factors on the Gravimetric wear of disc of disc harrow were determined. Empirical relationships were developed to estimate the wear life of the agricultural disc on the basis of field tests. The effect of steels on gravimetric wear of agricultural Disc was observed in field.

The cumulative wear increased as the working period increased for all four levels of hardness i.e. 36.3, 38.1, 42.1 and 41.5 HRC. The average maximum weight losses were 1004.75, 848.86, 705.74 and 549.88 g for 36.3, 38.1, 41.5 and42.1 agricultural disc hardness respectively. The high carbon steel weight loss in field soil i.e. silt clay loam is graphically represented in the Figure 1. The weight of Agricultural disc decreased with increase in time for all the tested Agricultural Disc. This result is in confirmation with the findings of Raval and Kaushal (1990), Kurchania (1997), Mahapatra (2002), Chahar and Tiwari (2009) and Kakade *et al.*, (2014). This increase in wear was due to wide range of abrasives in the field soil is more compactness. Cumulative wear at different periods of work for four levels of surface hardness were statically analysis and found significant at 5% level of significance. it was observed that the cumulative wear of T1 discwas1.83 times more for T4 disc.

The results showed that by increasing the surface hardness of agricultural disc from 36.3, 38.1, 41.5 and 42.1 HRC, the wear rate decreased from 2.13 to 1.15 gh^{-1} (53.1 % reduction).The hardness of the disc surface in comparison to the hardness of the grain of soil prevents the plastic deformation of the surface material and penetration of grain particles so that surface particles are not displaced. The degree of penetration is inversely proportional to the hardness of the surface. However, hardness of the surface also increases the brittleness of the material. Also much of the subsurface deformation during abrasive wear is repetitive in nature and hence, a high fatigue strength of material is helpful. Generally, the fatigue strength of the metals increases as a fractional power of the hardness. These factors produce a fractional increase of wear resistance with hardness of hardened metals. The effect of hardness of discs on the wear rate during the experiment was statistically analyzed and found significant.

Interaction effects of time on wear loss of agricultural discs by soil

A statistical analysis was also carried out to find the significant effect of hardness on wear of discs. ANOVA shows that the main effects of were highly significant on wear loss.

The values of the coefficients and the significant factors are presented in Table 1. It shows that these models are adequate to describe data sufficiently as R^2 value computed are 97.50 % the rate of wear is predicted by regression equation. A Linear regression analysis was carried to correlate the wear loss (W) of disc and hardness (H), which is as follows

$$W=1.2 - 0.0980 H \qquad ...Eq. 2$$

Where, Wis weight reduction in gm and H is hardness. Analysis of Variance shows that the effect of time on wear loss in weight reduction was significant at 5 per cent level.

Table.1 Chemical composition (wt%) of high carbon steel- (EN- 42)

	Fe 26	**C 6**	**O 8**	**Mn 25**	**S 16**	**Si 14**	**Ca**	**Al**
T1	91.74	3.24	3.07	1.53	0.30	0.25	-	-
T2	72.78	3.53	23.15	1.08	0.26	0.54	0.20	0.10
T3	81.86	3.58	9.10	1.29	0.44	0.55	0.18	-
T4	82.48	1.63	9.14	1.22	0.14	0.48	0.23	0.04

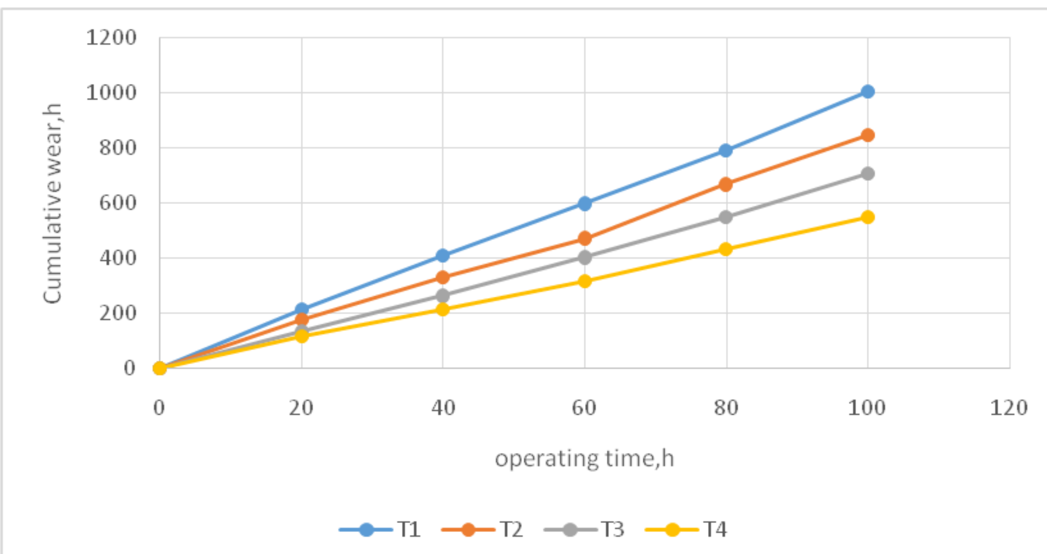

Fig.1 Effect of work period on cumulative wear in field condition

The make of discs T1(36.3), T2(38.1) and T3(41.5) gives marginally greater wear resistance in comparison to T4(42.1).

The make of disc after field test show significant weight loss due to abrasive action of soil particles which have mostly occurred on the outer end of leading edge towards the base of the disc.

It can therefore be concluded that the wear loss was increase when the hardness is decreased.

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