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Application of Image Processing for Determination and Comparison of the Abrasive Wear in Chisel Tines and Moldboard Blades

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Abstract: Determination the wear of tillage tools such as blades has a particular importance that is often achieved by weighing method. The purpose of this study was the usage of image processing methods for determination and comparison the wear of the moldboard blades and chisel tines instead of weighing method and determination the best abrasion resistant material for the blades. In this study three different moldboard blade and chisel tines were used. Blades were eroded in the equal soil conditions at five different stages during 30 hectares plowing. At each stage of abrasion, images were taken from the blades with a digital camera in a domed chamber having a uniform illumination. Images were then processed using Matlab software and the values of wear were determined as a percentage ??of surface and weight. Results showed that there was a significant difference between the blades which proposes the best combination of the structural elements for the blades as 27% C, 26% Si, 1.25% Mn, 0.4% Cr, 0.16% Ni and 0.023% S.

Key words: Blade · Image processing · Plow · Structure · Weight · Wear

INTRODUCTION

Image processing is a new science that its history goes back to the invention of computers. However this new science has been progressed in recent decades from both theoretical and practical aspects. This progress has been fast enough that now the subject of image processing can be seen in many industrial sciences. In this study, the aid of this knowledge the wear in three moldboard and chisel blades was determined. A new method for measuring the wear of drill tip with image processing was proposed by Pfeifer and Elmer (2002) which represented a strong correlation between the wear of drill tip and the tool life. Results also showed that the exact amount of wear can be determined by this method [1]. Wang and *et al*. (2005) stated a new system based on image analysis for measuring the wear edge rotation axes. They also began to compare its performance with a static method. The results showed that sequential image processing technique for industrial applications and measuring the wear on the spinning edges had a very high Efficiency comparing to the previous methods [2]. Jurkovic and *et al.* (2005) introduced a reliable method for direct measurement of tool wear parameters. They concluded that modern techniques of image processing are more flexible in measurement and spatial resolution with higher accuracy looked at the abrasive wear in tools [3]. Owsiak *et al.* in 1997 looked at the wear in four types of steel in soil at the cultivator blades. They found out that the effects of abrasion wear rate significantly reduced with the addition of carbon steels and the length of the blade was reduced with a linear relationship with the distance. They also stated that the wear of cutting edge of the blade depends on the distance to the tip of the blade and the soil type [4]. Tasan *et al*. (2005) presented a new method for measuring the wear. With the usage of an optical microscope they could measure the wear produced by a special device. An advanced algorithm was used to process a series of consecutive images of optical microscope to determine the wear. It was based on the difference between consecutive images [5].

Effects of soil properties and the abrasive particles particularly the shape and hardness on the abrasive wear of three metal samples were analyzed by Stachowiak *et al*. (2001). The tests were made on the pin over a reformed disk by abrasive particles. The abrasive shot was made ??by mixing water and sand and the results showed that the wear rate had a high correlation with angular particles in the shot tests and worn surface morphologies depend on the form of abrasive particles [6].

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Castejon *et al.* [7] Proposed a new method based on using image processing which used a computer program to analyze the data by a statistical program to determine the abrasive wear of a CNC machine parts to determine the end of their service life.

The objectives of this study were:

- The usage of image processing methods for determination and comparison the wear of the moldboard blades and chisel tines instead of weighing method and determine the correlation of between two methods.
- Determine the best abrasion resistant material for the blades.
- Extension and propagation the application of image processing in the fields of agriculture.

MATERIALS AND METHODS

For this study, wearing of chisel and moldboard blades was carried out in the lands with area of ??150 hectares in the Faculty of Agriculture at Shiraz. Three different types of moldboard and chisel blades were selected in three replications. Chisel blades was made in Iran, Brazil and Germany and moldboard blades was made in companies of Bellota, Kuhn, Kverneland, respectively in the countries Spain, France and Norway and any blade numbered with type 1, 2,.., 6 (Table 1, 2). An ITM399 tractor with power of 110 hp and mean speed of 2.6-5 km/h was used for plowing operations. To carry out the study, uniform conditions such as moisture, soil texture and the tractor speed was considered. Plowing operations in five stages was performed and each stage with specific surface area of ??30 hectares. Working width was 1.2 m and the distance between rows of chisel blades on branches was 30 cm. At each stage, the blades were moved on their own rows. Position of each blade was changed in each block on the shank as all blades were used to work in different positions so that the position of the blades could be changed. Therefore the effect of replications and treatments were removed in this method. The blades of chisel were mounted in two rows and in a moldboard plow in each stage three blades with different structure and three replications were used in a randomized complete block design for plowing operations. After plowing operations at each stage, the blades were separated and cleaned and imaged before wear and after (Figure 1).

Table 1: hree types of moldboard blades

blade	Type
Kverneland	1
Kuhn	2
Bellota	3

Table 2: Three types of chisel tines

blade	Type
Iran	4
Germany	5
Brazil	6

Fig. 1: Images of chisel tines a) before wear b) after wear

Fig. 2: Schematic of with removed domed shap on platform platform

Image processing method was used to deal with the problem of measuring the wear on the surface and the front edge thickness of the blade.

For imaging, a digital CCD camera was used with specifications of brand Canon IS 960UIXS model and 12 megapixel resolutions. In this study, among various methods of lighting, a lighting method of so called "cloddy sky" was used as the research platform (Figure 2). The light was projected from below to dome shaped ceiling and its reflection was used to lighten

Fig. 3: Schematic of method imaging

Fig. 4: Binary image of the worn blade.

the object in the center. Such kind of lighting would produce images with no shadows. To enhance the quality, four lamps of 12-volt halogen with white light with 90-degree angle to each other were used. DC power supply was used for uniform lighting. Images were taken from a distance of 40 cm above the blades.

Images were retrieved into the MATLAB software using image processing toolbox ver. 7. course, because of the wear areas on the blades was problem in the MATLAB software and the algorithm of the edge wear areas as well as in the histograms is not clear and with the background image was colored and in determination the area of ??the wear areas increased the error coefficient and inevitable for determining the wear parts was used the Photoshop software. Then the images in Photoshop to reduce the errors were saved with bmp suffix. Then these images into the MATLAB software and after the call were converted to binary.

After executing the program, images must be inverse according to the Figure (4) and the background was colored to black and blade to white because of the program algorithm was designed which for determining of the blade area take in the values ??of the one from the pixels that have the white color. Finally to determine the blade and wear area the coding methods was use in each stage.

RESULTS AND DISCUSSION

After each plowing the blades were cleaned and weighed, then were taken to the imaging platform and the images in each stage were transferred to programming and Photoshop environment. After analyzing the images in each step the data were examined in excel and SPSS software.

The results are as follow:

Figure 5 Showed that with increasing of plowing area the percentage of weight reduction related to initial weight was increased but the reduction values are lower in each stage related to its previous stage and the type 2 of moldboard blades had a lowest abrasion weight.

Figure 6 Showed that with increasing of plowing area the percentage of surface reduction related to initial surface was increased but the reduction values are lower in each stage related to its previous stage and the type 2 of moldboard blades had a lowest abrasion of surface and best structure.

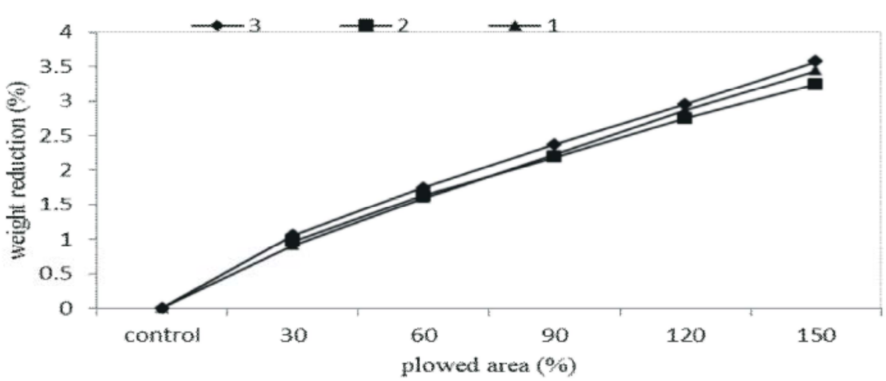

Fig. 5: The relation of plowed area and weight reduction for three types of different blades.

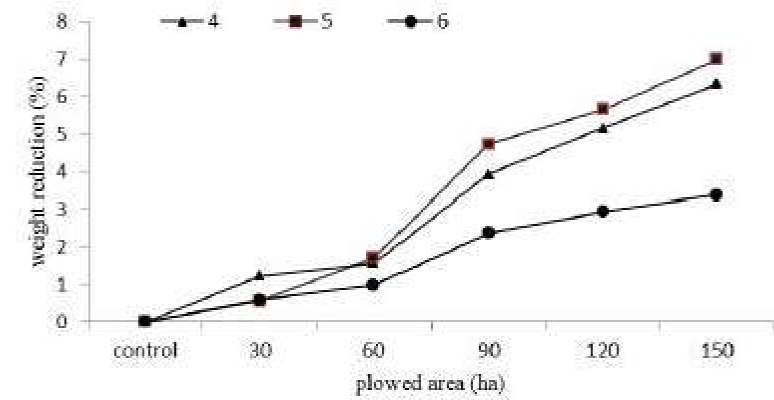

Fig. 6: The relation of plowed area and weight reduction for three types of different blades.

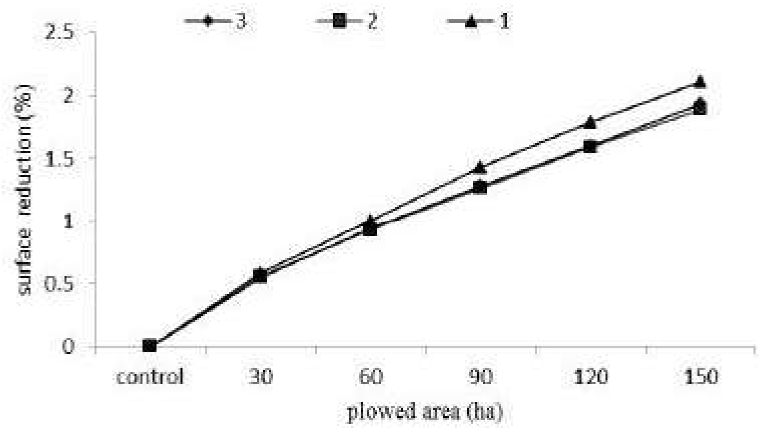

Fig. 7: The relation of plowed area and surface reduction for three types of different blades.

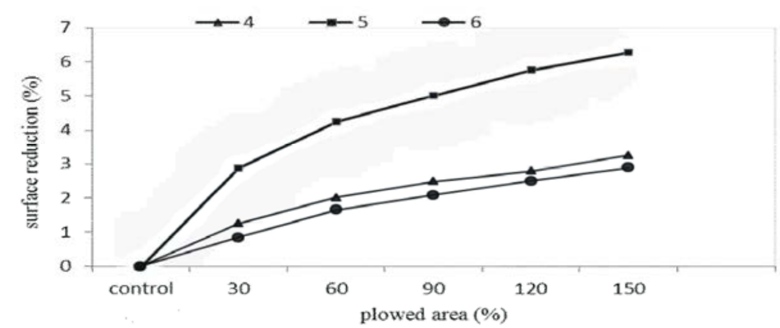

Fig. 8: The relation of plowed area and surface reduction for three types of different blades.

Figure 7 Showed that with increasing of plowing area the percentage of weight reduction related to initial weight was increased but the reduction values are lower in each stage related to its previous stage and the type 6 of chisel tines had a lowest abrasion weight.

Figure 8 Showed that with increasing of plowing area the percentage of surface reduction related to initial surface was increased but the reduction values are lower in each stage related to its previous stage and the type 6 of chisel tines had a lowest abrasion of surface and best structure.

The Figure 9 showed that there were a ideal correlation of weight reduction and surface reduction.

it appeare that for three types (1, 2, 3) of different blades with had the each could be detemined the other approximately.

The Figure 10 showed that there were a ideal correlation of weight reduction and surface reduction for types (4, 5, 6) of chisel tines and from the each them could be detemined the other almost completely.

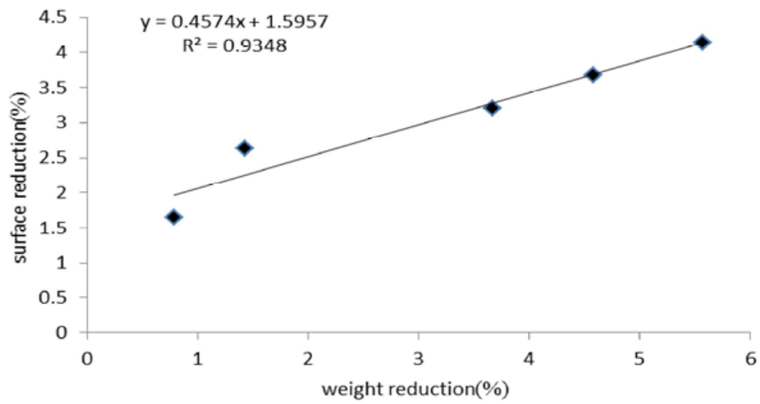

Fig. 9: The correlation of weight reduction and surface reduction for threee types (1, 2, 3) of different blades

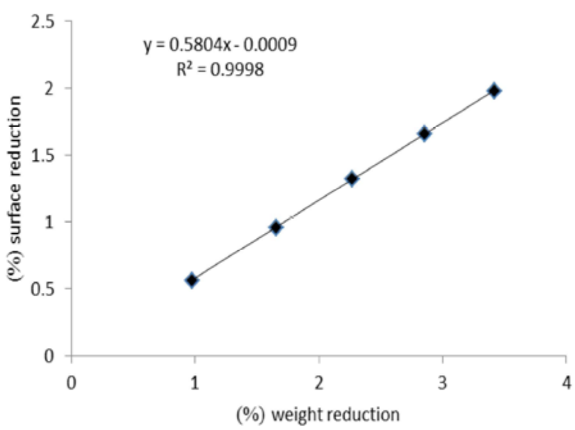

Fig. 10: The correlation of weight reduction and surface reduction for threee types (4, 5, 6) of different blades

Table 3: Comparison of averages of weight loss after plowing the 150 acres at the 1% level for moldboard blades

Average of weight loss per blade related to initial weight (%)		Type (Treatment)
3.4427	b[*]	1
3.2468	c	2
3.5734	b	3

Table 4: Comparison of averages of surface loss after Plowing the 150 acres at the 1% level for moldboard blades

Average of surface loss per blade related to initial surface (%)		Type (Treatment)
2.1093	b[1]	1
1.8887	c	2
1.9345	b	3

Table 5: Comparison of averages of weight loss after plowing the 150 acres at the 1% level for chisel tines

Average of weight loss per blade related to initial weight (%)		Type (Treatment)
6.3255	a	4
6.9688	c	5
3.3832	b	6

Table 6: Comparison of averages of surface loss after plowing the 150 acres at the 1% level for chisel tines

Average of surface loss per blade related to initial surface (%)		Type (Treatment)
3.2524	a	4
6.2858	c	5
2.8881	b	6

The table 3 showed that after looked at the data in SPSS software was presented that the average of loss weight for three replications in 150 hectare related to initial weight for type 2 had the lowest abrasion.

The table 4 showed that after looked at the data in SPSS software was presented that the average of loss surface for three replications in 150 hectare related to initial weight for type 2 had the lowest abrasion and best structure.

The table 5 showed that after looked at the data in SPSS software was presented that the average of loss weight for three replications in 150 hectare related to initial weight for type 6 had the lowest abrasion.

The table 6 showed that after looked at the data in SPSS software was presented the average of loss weight for three replications in 150 hectare related to initial weight for type 6 had the lowest abrasion and best structure.

[1]The blades that have a same symptom are not significant difference

CONCLUSION

Reviewing the wear in weight scale as well as blade surface it could be concluded that the type 2 and type 6 had the best structure between the three types of the blades in their category. Also in comparison between these two blades, the type 2 showed more resistance and durability.

Good agreement between the wear measurements achieved by weighing methods and image based measurements represented a good agreement between the two methods which states that the method of image processing could be used as a reliable and convenient tool for measuring the wear of the blades especially in cases that the wear occurs in two dimensions.

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