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Comparison among Three Chisel Plough Shares Forms

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ABSTRACT

A comparison among three chisels plough shares forms *i.e.*, shovel with a width of 10 cm, breaker sweep with a width of 15 cm and wing with a width of 20 cm was executed with soil having a silt loam texture under constant operating circumstances. The main results of the current study can be summarized as follows; The soil surface after ploughing with shovel shares form possessed the greatest percentage of the roughness (59.03%), whereas utilization of the breaker sweep and wing shares form leaved the soil surface with roughness of 51.9 and 37.9%, respectively. The percentage ploughed area after ploughing at depth of 18 cm was 55.37%, 64.2695 and 75% from the total area with usage of shovel, breaker sweep and wing shares forms, respectively. The power required for ploughing process at an operating depth of 18 cm and forward speed of 0.8 m Sec^{-1} were 7.92, 11.76 and 9.3 kW, while the unit draught of soil was 0.62, 0.8 and 0.54 kN cm^{-2} concerning the shovel shares form, breaker sweep shares and wing shares form, respectively. Generally, it can be concluded that the chisel plough with wing shares form is the most suitable primary tillage implement.

***Keywords**:* Shove share, breaker sweep and wing.

INTRODUCTION

Chisel plough is a widely used primary tillage implement in Egypt due to its several advantages . It can be used in a wider range of soil circumstances. It doesn't lead to the hard soil pan which often occurs with the mouldboard plough, where it leaves residues on the soil surface causing minimizing both wind and water erosion. It is also easier to maintain, manufacture, operate and leave a cultivated soil with lower salt and alkaline content particularly after the construction of the Aswan high Dum.Thus, crop yields are better (EL-Khateeb *et al.*, 2009 and Hegazy *et al.*, 2021).

The draught force of the chisel plough is a linear function of the speed of operation and directly proportional to ploughing depth. On the other hand, at a given ploughing depth, the unit draught of soil according to ploughing speed for Beheira chisel plough, subsurface sweep flat plough and a subsurface wing plough. The subsurface sweep or wing ploughs possess less unit draught compared to the Bebeira chisel plough (Abo El-Khair, 1987; Mohamed and Younis, 2015 and Hoseinian *et al.*, 2022).

The ploughed cross-sectional area of a tillage tool is a function of ploughing depth, width of the tool and furrow angle for a given soil type and condition. The furrow angle is the angle between the rupture line and the horizontal, Krause and Loren (1979) reported that the value of furrow angle is about 50 in relatively dry soil and increases with the soil moisture content increased. Korayen *et al.*, (1985) in some field trials using a Beheira chisel plough. The treatments involved ploughing once and twice such that the twice ploughing was in two perpendicular directions. The findings showed that the percentage of the areas left without ploughing after ploughing once and twice was nearly 29% and 16.7%, respectively. Generally, they concluded that a second pass is necessary under usage of the chisel plough to ensure a good ploughing quality.

The current work aims to compare among three chisels plough shares forms *i.e.*, shovel with a width of 10 cm, breaker sweep with a width of 15 cm and wing with a width of 20 cm.

MATERIALS AND METHODS

1. Site Description.

The current field trait was performed in a private farm located in Sherbien region, El- Dakahlia Governorate, Egypt (31°03′16″N 31°22′30″E) during season of 2020.

2. Soil sampling.

Soil sample was taken at a depth of 0-25 cm by auger then analyze according to Dane and Topp (2020) for soil mechanical analysis, where the soil possess a silt loam texture and contained 10 % of sand, 70% of silt and 20 % of clay. Other characteristics of the initial soil were shown in Table 1.

Table 1. Some characteristics of the initial soil.

Saturation (SP),%	90
Field capacity (FC),%	45
Witting point (WP),%	22.50
Available water (AW), %	22.50
Hygroscopic water (H.W),%	9.80
Real density (Mg m^{-3})	2.65
Permeability index (PI)	0.75
Bulk Density (Mg m^{-3})	1.27
Total Porosity%	51.30

3. Setup.

The field trial was implemented by means of a trailed mechanically lifted chisel plough of three shares arranged in

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one row. The tine spacing was 54 cm. Three different shapes of locally manufactured chisel plough shares were used in this study as shown in Fig.1. The 1st shares was a shovel form (with a width of 10 cm), while the 2nd shares was a breaker sweep (with a width of 15 cm) and the 3rd shares was a wing form (with a width of 20 cm). All treatments were replicated three times.

Dimension in mm.

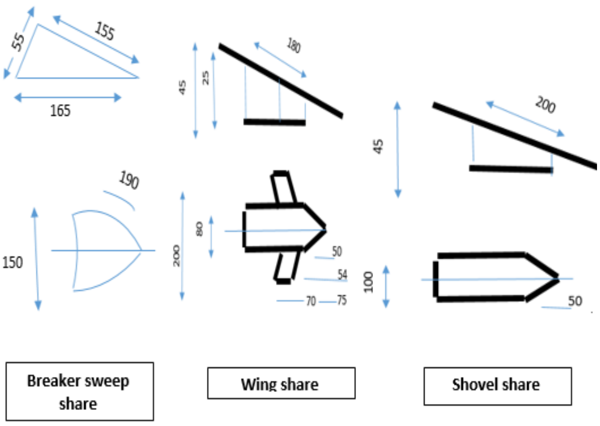

Fig 1. Types of chisel plough shares forms.

Using a penetrograph, the soil penetration resistance was measured depending on Eojkelkamp, (1979). While the tilled cross-sectional profile can be estimated with a relief measurements apparatus adapted from Willatt and Willis (1985). The cross-sectional area can be determined from the cross-sectional elements using the trapezoids rule as given in the following equation;

$$A = L/2\ (a + 2b) \qquad (1)$$

Where

A is total cross-sectional area, L is constant horizontal distance, a is sum of first and last ordinates and b is sum of all ordinates excluding the first and last ones.

The soil surface roughness was determined depending on Kuipera equation (1957) as follows:

$$R = 100 \log_{10} S \qquad (2)$$

Where

R is soil surface roughness (%), S is standard deviation (cm.). The standard deviation was estimated by measuring the distance between a constant horizontal surface and soil surface in the known distance.

An electric dynamometer (Type U2A-5t 2mV/V) from BHM, W. Germany with which a register unit had been attached was used to measure, display and record the draught together with the time taken.

RESULTS AND DISSCUSION

1. Resistance of soil penetration.

The resistance of soils to penetration depends upon their physical and mechanical characteristics, the operating circumstances i.e., speed, width and depth as well as the penetrating tool toiletry. Prior soils cleavage reduces their penetration resistance. The farther, the soil cleavage the less its impact on the penetration resistance.

Fig 2 shows the influence of the chisel plough shares form on the resistance of studied soil to penetration. Ploughing with shovel and breaker sweep shares forms reduced the resistance of studied soil to penetration in the middle distance between two tines up to a depth of 10 cm. Whilst, the utilization of the wing shares form pronouncedly decreased the soil penetration resistance under all levels of depth till 18 cm. From the obtained results, it is obvious that the wing shares was superior compared to the shovel and breaker sweep sharess because it left the tilled soil with the least penetration resistance.

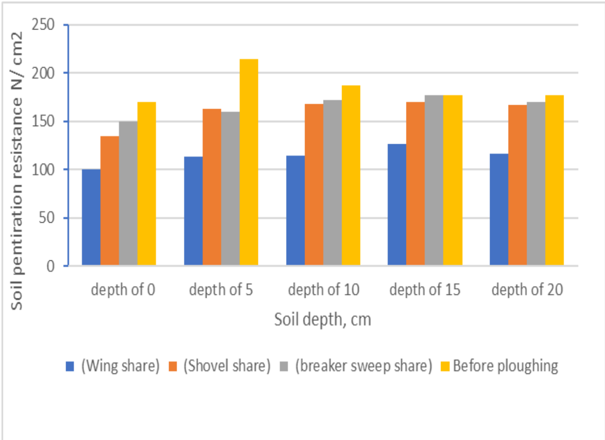

Fig 2. Effect of shares forms on the resistance of soil penetration in the middle distance between two tines.

2. Tilled cross-sectional area.

Fig 3 illustrates the impact of the chisel plough shares form on the tilled cross-sectional area. The profile of the tilled cross-sectional soil was estimated after the removal of the ploughed soil. The ploughed areas were calculated (using equation 3) from the obtained profiles. The percentages of the ploughed area after ploughing at depth of 18 cm were 55.37%, 64.2695 and 75% from the total area with usage of the shovel, breaker sweep and wing shares forms, respectively.

The furrow angle can be measured if the cross-sectional area of the furrow and depth as well as the width of the tool are known. However, for this purpose, equation number 2 can be applied. Applying this equation for the given values of depth and width of ploughing tool of this work together with the practically measured cross-sectional area, the furrow angle has been found to be 47.86°, 47.589 and 48.71 after ploughing with the shovel, breaker sweep and wing shares forms, respectively. To some extent, these values of furrow angle are in conformity with Krause and Lorenz, (1979). Therefore, the wing shares form represented the best one in the tilled cross-sectional area compared to other types of sharess.

3. Roughness of soil surface.

The surface roughness of cultivated soil is an essential trail to assess the tillage performance, where it affects the resulting seedbed attributes and contributes to cutting the amount of required irrigation water. Fig 3 illustrates the impact of the chisel plough shares form on the roughness of the studied soil surface.

After ploughing, the soil surface with shovel shares form afford the greatest percentage of the roughness (59.03%), whereas utilization of the breaker sweep and wing shares form left the soil surface with a roughness of 51.9 and 37.9%, respectively. Thus, the most suitable seedbed for the irrigation regime in Egypt with minimum secondary tillage could be realized when the usage of the chisel plough with wing shares form as primary tillage is implemented.

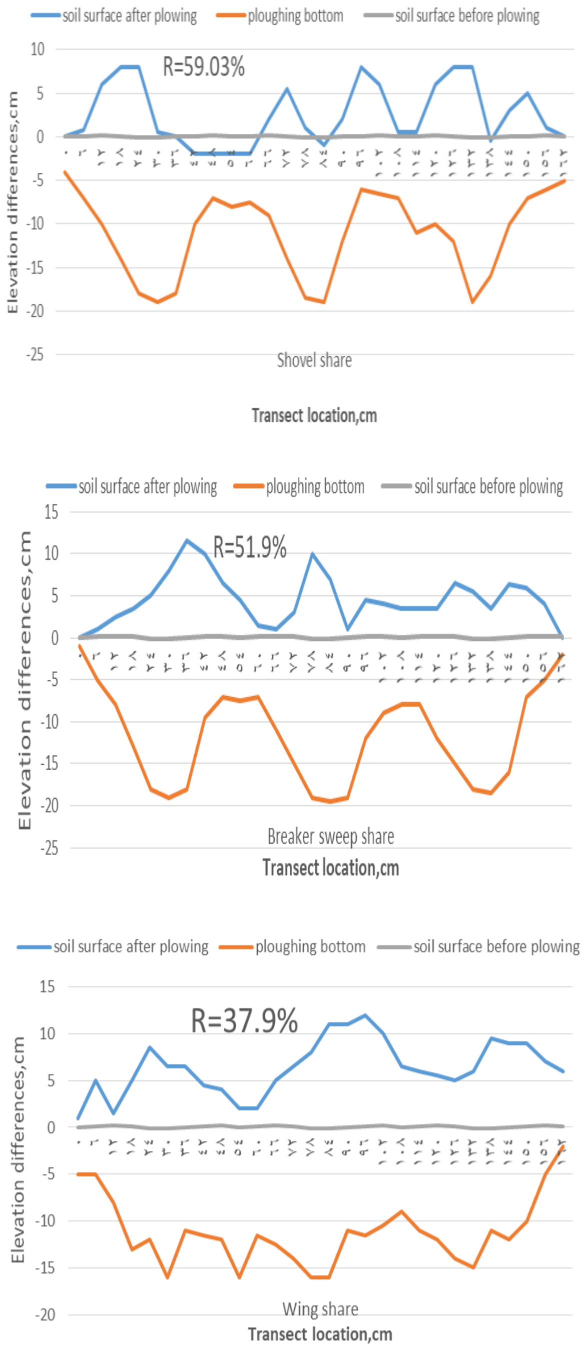

Fig 3. Soil cross-section and soil surface roughness after ploughing with three shares trailed chisel plough with three shares forms.

4. Requirements of power.

The draught was measured followed by calculating the unit draught of the soil by dividing the draught by the cross-sectional areas. Fig 4 illustrates the requirements of power for the three tines chisel plough with shovel, breaker sweep and wing shares form.

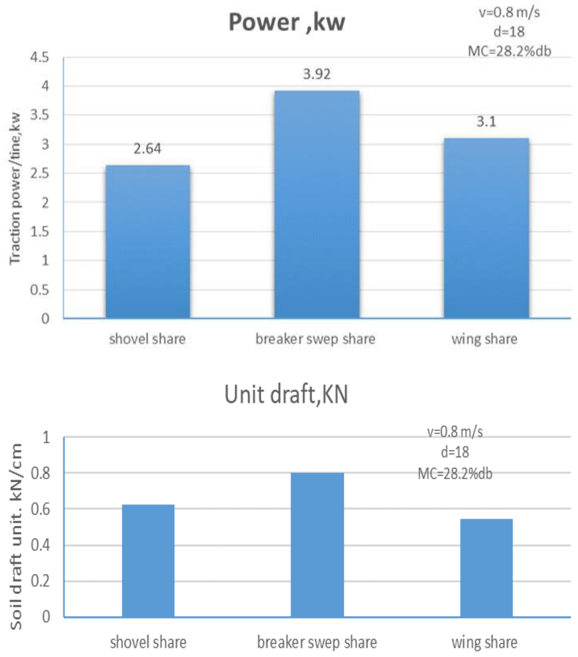

Fig 4. Effect of shares forms on the power required and the draught unit of soil.

The power required for ploughing process at an operating depth of 18 cm and forward speed of 0.8 m Sec^{-1} under using the shovel shares form was 7.92 kW, while the unit draught of soil was 0.62 KN cm^{-2}.

Regarding the breaker sweep shares under the above working circumstances, the required power was 11.76 kW, while the unit draught of soil was 0.8 KN. cm^{-2}.

Usage of the wing shares form required a power of only 9.3 kW, while the unit draught of soil was only 0.54 KN cm^{-2}.

Consequently, the wing shares may be considered as the superior form for primary tillage unit.

CONCLUSION

It can be concluded that the three tines chisel plough with wing shares form is the most suitable primary tillage unit for a combine tillage unit, that prepares the seed bed in one operation due to the following reasons: -

1. It left a greater cultivated cross-sectional area and a minimum soil surface roughness.
2. Its power requirement doesn't exceed 25% from the widespread tractor power range (30-40 kW) in Egypt.
3. It left the cultivated soil with the minimum value of soil penetration resistance and unit draught.

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مقارنة بين ثلاث اشكال مختلفة لأسلحة المحراث الحفار.

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تم إجراء مقارنة بين ثلاث اشكال مختلفة لأسلحة المحراث الحفار (لسان عصفور بعرض ١٠ سم، ورجل بطة بعرض ١٥ سم ومجنح بعرض ٢٠ سم) مع تربة ذات قوام سلتي طمي في ظل ظروف تشغيل ثابتة. يمكن تلخيص النتائج الرئيسية للدراسة الحالية على النحو التالي؛أوضحت النتائج أن سطح التربة بعد الحرث بالمحراث الحفار ذات سلاح لسان عصفور بعرض ١٠ سم امتلك أكبر نسبة من الخشونة (٥٩,٠٣٪)، بينما استخدام أسلحة رجل بطة والمجنح ترك سطح التربة بخشونة ٥١,٩٣٦ و٣٧,٩٪ على التوالي. من ناحية أخرى، بلغت نسبة مساحة الحرث بعد الحرث بعمق ١٨ سم ٥٥,٣٧٪ و٦٤,٢٧ و٧٥٪ من المساحة الكلية باستخدام سلاح لسان عصفور، ورجل بطة ومجنح على التوالي. القدرة المطلوبة لعملية الحرث على عمق ١٨ سم وسرعة أمامية ٠,٨ متر/ ثانية كانت ٧,٩٢، ١١,٧٦ و٩,٣ كيلو واط، بينما كانت وحدة مقاومة التربة ٠,٦٢، ٠,٨ و٠,٥٤ كيلو نيوتن/ سم^2 فيما يتعلق باستخدام سلاح لسان عصفور، ورجل بطة ومجنح على التوالي. بشكل عام، يمكن استنتاج أن المحراث الحفار ذو الأسلحة المجنحة هو أنسب معدة للحرث الرئيسي تصلح في ظل الظروف المصرية.