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The Effect Of The Penetration Angle Of Two Types Of Shanks And Shares Subsoiler Plow On Some Field Performance Indicators

Ibrahim Saleh Ibrahim Al-Zubaidi and Saad Abdul-Jabbar Samir Al-Rajbo

Department of Agricultural Machines and Equipment, College of Agriculture and Forestry, University of Mosul, Iraq.

Abstract

This study was conducted with the aim of evaluating the field performance of the locally manufactured shank and share Subsoiler plow and comparing them with the conventional shank and share through a field experiment in which the following factors depended: the type of shank by two levels (the conventional shank , the locally manufactured shank) and the share type by two levels (the traditional share , the locally manufactured share) and with two angle penetration (40º, 50º) and the effect of this on (Drawbar Power, fuel consumption, Slippage percentage, Distribution Area), Where the experiment was conducted in the autumn agricultural season (2020) in an agricultural field located in the Abbasiya area in Nineveh province. The field was divided according to the randomized complete block design (RCBD) for a factorial experiment with three replicates. Duncan's multiple range test was used to compare the averages. The following are the most important findings studying, , the locally manufactured shank achieved the highest significant value for the distribution area, while the conventional shank achieved the lowest significant value for fuel consumption .While the locally manufactured share achieved the highest significant value for the distribution area, the angle penetration 40º achieved the lowest significant value for fuel consumption, Slippage percentage, and the highest significant value for the distribution area. The interaction between the conventional shank with the traditional share and the angle penetration 40º achieved the lowest significant value for fuel consumption, while the locally manufactured shank and share with the penetration angle 40º achieved the highest significant value for the distribution area.

Keywords: Subsoiler plow, shank type, share type, angle penetration, field performance indicators

Introduction

The agricultural process of any agricultural crop requires conducted several operations, starting from tillage and ending with placing the seeds in the seedbed, where the tillage process is one of the most important operations conducted on the soil for the purpose of preparing it for cultivation. Where the main aim of tillage soil is to prepare the appropriate the seedbed, as the tillage process achieves a balance of air and water inside the soil, thus creating the appropriate climate for seed germination and root growth. The soil tillage is considered one of the special treatments of soil preparation equipment and one of the most important agricultural machines used in the field because of its importance in the reclamation of agricultural lands, as well as its ability to get rid of the hard pan and reduce its harmful effects on the physical and chemical properties of the soil and that this layer occurs as a result of the use of tractors and heavy machinery, which results in compaction of the soil through repeated work for many years, where well as a result of chemical reactions in the soil and the misuse of irrigation, which can lead to the cohesion of soil granules over time as the formed layer leads to resistance to the extension of the roots It also reduces soil moisture retention, aeration, and excess water drainage, which leads to poor growth and plant production. (Mustafa and Al-Sahar, 2007), The shanks shape has an effect on the power requirements of Tractor as the vertical shank achieved the lowest fuel consumption rate, while there was no significant difference between the forward deviated shank and the arched shank , and the reason for the increase in the fuel consumption rate was due to the increase in as a result of increased draft force and slippage percentage (Ragbo and Al-Tai, 2007).).Abdullah and Hilal (2017) indicated in a study that there are significant differences between the angles of penetration in the drawbar power, as the angles of penetration 50 ° achieved the highest drawbar power compared to the penetration angles of penetration 30 °, and that the increase in the angle penetration from 30 ° to 50 ° for the Subsoiler plow led to a decrease in the disruption width on the surface. The angle 50º achieved the lowest disruption width, while the angle 30º achieved the highest disruption width as it is reflected on the distribution area.In a comparative study, four models of the draw bar Subsoiler (straight draw bar, semi-equivalent draw bar, arched draw bar, straight draw bar with the addition of wings to the foot)The arched draw bar achieved the lowest drawbar power, while the shanks with the winged foot achieved the highest drawbar Power, due to the reason for the increase in the drawbar Power as a result of adding wings to the plow feet, which led to an increase in the rate of disruption soil due to the increase in the share area (Odey et al., 2018). Al Hanoush (2020) indicated in his study comparing the performance of a Subsoiler plow with different forms of locally manufactured shank in traits of some machine and soil indicators, to the excelled of the curved shank by recording the lowest value for the drawbar Power, followed by the curved shanks, while the straight shanks recorded the highest value for the force . The change in the amount of angle penetration gives a significant effect on the amount of fuel consumed (Abdul-Jabbar, 2011) The increase in the angle of penetration from 30º - 35º recorded an increase in the average of fuel consumption, as well as the change in the angle of penetration, gave a significant effect on the slippage percentage, In their study, Al-Hanosh and Al-Jarrah (2020) noted that the curved shank was significantly superior in recording the lowest value for fuel consumption, which did not differ significantly from the curved shanks. Whereas, the straight shanks recorded the highest value for fuel consumption, and the reason for this was due to the fact that the force required to draft and the draw bar of the straight shanks was high compared to the rest of the shanks . In a comparative study between the traditional share and the manufactured for the Subsoiler plow between Tahir and et al (2018) that the manufactured share recorded the highest slippage percentage, while the traditional share recorded the lowest slippage percentage, due to the reason for the increase in Slippage percentage to the fact that the manufactured share has a greater width than the traditional and requires greater drawbar power which increased slippage percentage, As Ramadhan (2014) observed when adding wings to the Subsoiler plow feet , the disturbed soil area increased as a result of the increase in disturbed width ,There is an increase in the area of the disturbed soil area when using the manufactured share compared to the traditional share of the Subsoiler plow

Materials and methods

The experiment was conducted in October for the agricultural season 2020-2021 in an agricultural field located in the Abbasiya area, and the topography of the field was characterized by its flatness ,The sprinkler irrigation system was adopted. The field was divided according to the Randomized Complete Block Design (RCBD), (Daoud and Elias 1990), for a factorial experiment with three factors:

1- The first factor, the type of shanks with two levels (the conventional shanks , the locally manufactured shanks).

2- The second factor, the type of weapon and at two levels (the traditional share, the locally manufactured share).

3- The third factor, the angle of penetration in two levels (angle 40º, angle 50º)

Thus, the number of factorial treatments in the experiment becomes eight (2 * 2 * 2) and with three replicates, so that the number of experimental units is (24) experimental units. The averages were tested with the Duncan's multi-range method. Where a locally manufactured single share Subsoiler plow produced by the Mosul Mechanical Works Company was used. A new shanks and weapon were manufactured in the North Mechanical Works Company to compare with the conventional shanks and share of the plow.

1- The first factor, the type of shanks with two levels (the conventional shanks , the locally manufactured shanks).

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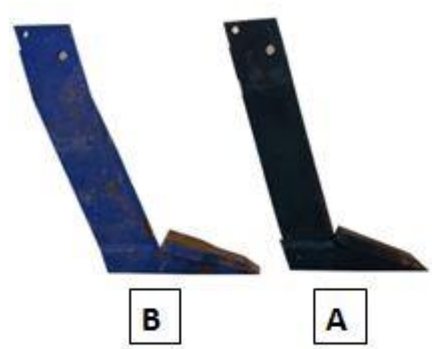

Figure (1) The shanks used

A = conventional shank B = locally manufactured shank

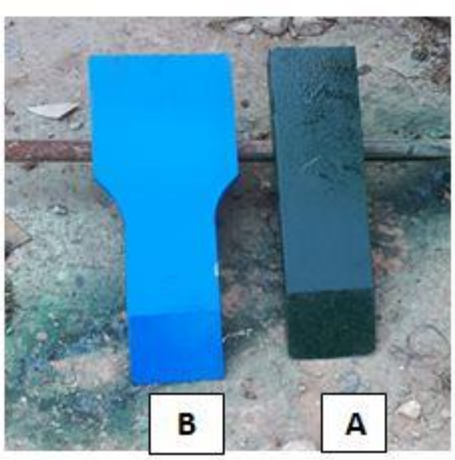

Figure (2) The share used

A = traditional share B = locally manufactured share

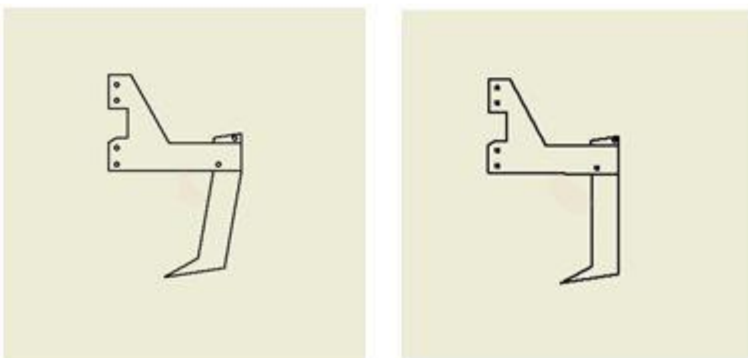

Figure (3) shows the traditional and locally manufactured shank when they are attached to the plow frame

The studied indicators and the equations used in calculating them were:

1-Drawbar Power (kilowatts): It represents the product of the force multiplied by the speed, as it was calculated by the following equation (Kheiry et al., 2019):

$$DP = Ft * VP$$

Dp: draw bar power (kilowatts).

Ft: draft force (kN).

VP: draft speed (m/sec).

2- Fuel Consumption (L / hour): Fuel consumption was measured by the addition method, where a graduated cylinder was used to add fuel to the fuel tank of the tractor after the end of each transaction line (AL-Hashem et al., 2000), and it was calculated according to the equation the following (Yah, 1998):

$$Fc = (Fca/Tp) * 3.6$$

As:

Fc: the amount of fuel consumed per unit time (L/hour).
Fca: measured amount of fuel consumed (ml).
Tp: the actual time to complete the treatments. (sec.).

3-Slippage percentage (%): Slippage is the asymmetry between the length of the linear distance to the surrounding distance for a fixed number of revolutions of the wheels in the tug (Al-Banna, 1990), the Slippage percentage was calculated using the following equation (Southwell, 1953):

4-Distribution Area (m2): The amount of soil that is displaced by the machine used in the tillage, and this amount depends on the shape of this machine and its engineering dimensions and the disturbed soil area was measured by removing the plowed soil by hand until the unplowed section appeared, and the area of the stirred soil section was calculated based on the following equation, Hilal (2001):

Results and discussion

1- Drawbar Power (kw):

Table No. (1) shows that the effect of the type of shanks and the angle of penetration was not significant in the trait of the Drawbar Power, while the type of share was significantly excelled in the trait of the Drawbar Power .The locally manufactured share recorded the highest value of the Drawbar Power, which amounted to (10.5933) kilowatts, and the reason for this is due to the increase in the surface area of the locally manufactured share, which led to an increase in the average of disturbed soil, Which increased the draft force, which is considered one of the components of the Drawbar Power, that is, by increasing the draft force, the Drawbar Power increases, and this is consistent with (Odey et al., 2018) and (Tahir et al., 2018). It is noted from the table when the interaction between the type of shanks and the share, and although the calculated F value is less than the tabular F value, the Duncan test showed that there are significant differences, Where the lowest value of the Drawbar Power was recorded at the locally manufactured shank with the traditional share and its value was (10.0898) kilowatts, while the conventional shank with the locally manufactured share gave the highest value of the Drawbar Power, which was (10.6428) kilowatts. this is due to the increased draft force. As for the interaction between the type of shank and the angle of penetration, there were no significant differences, and there were also no significant differences when the interaction between the type of share, the angle of penetration and the triple interaction.

Table (1) The effect of the studied factors and their interactions on the trait of the Drawbar Power (kilowatts)

shank type	Share type	angle of penetration		The interaction between the shank and share	
		40	50		
traditional	traditional	10.0542	10.3278	10.1910 ab	
	manufactured	10.6560	10.6297	10.6428 a	
manufactured	traditional	10.2297	9.9499	10.0898 b	
	manufactured	10.6549	10.4329	10.5439 ab	
The interaction between	traditional	10.3551	10.4787	average	10.4169

the shank and the angle	**manufactured**	**10.4423**	**10.1914**	**shank type**	**10.3168**
The interaction between the share and the angle	**traditional**	**10.1420**	**10.1388**	**average share type**	**10.1404 b**
	manufactured	**10.6554**	**10.5313**		**10.5933 A**
average angle of penetration		**10.3987**	**10.3350**		

The lower value is the better.

2- Fuel consumption (L/hour):

Table (2) shows the significantly excelled in the type of shank in the trait of fuel consumption, where the conventional shank recorded the lowest value for fuel consumption, which amounted to (13.8991) L / hour. While the locally manufactured shank recorded the highest value for fuel consumption, which amounted to (14.3577) L/hour, This is due to the fact that the average of fuel consumption increases with an increase in both draft force and Slippage percentage, and this is consistent with (Moitzi et al., 2006) and (Al-Hanosh & Al-Jarrah, 2020).It is also noted from the table that the type of line was significant in trait of fuel consumption. The traditional line recorded the lowest value for fuel consumption, which amounted to (13.3012) L/hour, while the locally manufactured line recorded the highest value for fuel consumption, which amounted to (14,9557) L/hour. The reason for this is that the locally manufactured line has a wider surface, which increased the area facing the soil, which needs more strength and a greater Drawbar Power, and thus leads to an increase in the average of fuel consumption. The average of fuel consumption increases with the increase of both Drawbar Power and draft force. The table also shows that the angle penetration also achieved significant differences for the fuel consumption, as the angle 40º recorded the lowest value for fuel consumption, which amounted to (13.6422) L / hour, while the angle 50º recorded the highest value for fuel consumption, which amounted to (14.6146) L / hour. The reason for this is that the increase in the angle of penetration led to an increase in the volume of the soil pushed forward, which in turn led to the collision of the plowed soil with the non-plowed soil, which leads to the accumulation of a larger volume of soil in front of the plow, which leads to an increase in the resistance of the soil to the plow and an increase in the strength and Drawbar Power and thus increases The average of fuel consumption and this is consistent with what was reached (Abdul-Jabbar, 2011).The interaction between the type of shank and the share was significant, as the lowest value of fuel consumption was recorded, which amounted to (13.0963) L/hour at the locally manufactured shank with the traditional share , while the locally manufactured shank and share recorded the highest value for fuel consumption, which amounted to (15.6192) L/hour. The reason for this is to increase the drawbar power as mentioned previously. It is also noted from the table that there were significant differences at the interaction between the type of shanks and the angle of penetration, where the lowest value of fuel consumption was recorded, which amounted to (13.2030) L / hour at the conventional shank with angle 40º, while the locally manufactured stalk with angle 50º recorded the highest value for Fuel consumption , which amounted to (14.6340) L/hour and for the same reasons mentioned above. The table shows that at the interaction between the type of share and the angle of penetration, there were no significant differences, while there were significant differences at the triple interaction, where the lowest value for fuel consumption (12.3333) L/hour, which was recorded by the conventional shank with the traditional share with the angle of 40º, while it was recorded The locally manufactured shank and share with an angle of 50º had the highest value for fuel consumption, which amounted to (16.3549) L/hour.

Table (2) The effect of the studied factors and their interactions on the trait of fuel consumption (L/hour)

shank type	Share type	angle of penetration		The interaction between the shank and share	
		40	50		
traditional	traditional	12.3333 h	14.6788 b c	13.5061 c	
	manufactured	14.0727 c	14.5117 b c	14.2922 B	
manufactured	traditional	13.2795 d	12.9130 e d	13.0963 c	
	manufactured	14.8834 b	16.3549 a	15.6192 A	
The interaction between the shank and the angle	traditional	13.2030 c	14.5952 A	average shank type	13.8991 B
	manufactured	14.0815 b	14.6340 A		14.3577 A
The interaction between the share and the angle	traditional	12.8064	13.7959	average share type	13.3012 b
	manufactured	14.4780	15.4333		14.9557 A
average angle of penetration		13.6422 b	14.6146 A		

The lower value is the better.

3- Slippage percentage (%):

Table (3) indicates that the effect of the type of shank was not significant in the trait of the slippage percentage, and the table shows the traditional share significantly excelled in recording the lowest value of the slippage percentage, which amounted to (9.6670)%, while the locally manufactured share recorded the highest value of the slippage percentage, which amounted to (13.1703) %, The reason for this is that the locally manufactured share requires greater drawbar power and force than the traditional one, and this is consistent with what was confirmed by (Al-Rahim, 2009) and (Tahir et al., 2018), who mentioned that the slippage percentage depends on drawbar power and force, Where the highest values were recorded for the locally manufactured share. It is noted from the table that the effect of the angle of penetration was significant in the trait of the slippage percentage, where the angle of 40º recorded the lowest value and amounted to (10.6748)%, while the angle of 50º recorded the highest value of the slippage percentage, which amounted to (12.1625)%,This is due to the fact that the slippage percentage depends on the pulling force, where the angle of 50º recorded the highest value of the greater drawbar power, and this agrees with (Abdul-Jabbar, 2011). The table shows that the effect of the interaction between the type of stalk and the type of share was significant in the trait of the slippage percentage, where the locally manufactured stalk excelled with the traditional share by recording the lowest value of the slippage percentage, which amounted to (9.2168)%, while the locally manufactured stalk and share recorded the highest value of the slippage percentage , which reached (14.1158) % The reason for this is due to the shank shape and the share , as mentioned previously. The table indicates that the effect of the interaction between the type of shank and the angle of penetration was significant in the trait of the Slippage percentage according to Duncan's test, although the calculated F value is less than the tabulated F value. The lowest value of slippage percentage was recorded, which was (10.2468)% at the conventional shank with the angle of 40º, while the highest value of the slippage percentage was recorded at the locally manufactured shank with the angle of 50º, which amounted to (12.2298)%As for the interaction between the type of share and the angle of penetration, there were significant differences in the trait of the slippage percentage, where the traditional share with the angle of 40º excelled in recording the lowest value of the slippage percentage, which amounted to (9.2246)%, while the locally manufactured share with the angle of 50º recorded the highest value of the slippage percentage, which amounted to (14.2156)%The reason for this is due to the angle of penetration, as mentioned previously. It is noted from the table that there are significant differences at the triple interaction between the type of shank , the type of share , and the angle of penetration in the trait of the slippage percentage, The interaction between the locally manufactured shank with the traditional share and the penetration angle 50º recorded the lowest value of the slippage percentage, which amounted to (8.5860)%, while the highest value of the slippage percentage was recorded at the locally manufactured shank and share, and the penetration angle was 50º, which amounted to (15.8736)%.

Table (3) The effect of the studied factors and their interactions on the trait of the Slippage percentage (%)

shank type	Share type	angle of penetration		The interaction between the shank and share	
		40	50		
traditional	traditional	8.6016 c	11.6330 b	10.1173 c	
	manufactured	11.8919 b	12.5576 b	12.2248 b	
manufactured	traditional	9.8475 c	8.5860 c	9.2168 c	
	manufactured	12.3580 B	15.8736 a	14.1158 a	
The interaction between the shank and the angle	traditional	10.2468 b	12.0953 a	average shank type	11.1710
	manufactured	11.1028 b	12.2298 a		11.6663
The interaction between the share and the angle	traditional	9.2246 c	10.1095 c	average share type	9.6670 b
	manufactured	14.2156 a	14.2156 a		13.1703 A
average angle of penetration		10.6748 b	12.1625 a		

The lower value is the better.

Distribution Area (m²):

Table (4) shows that the effect of the type of shank was significant on the trait of the distribution area, where the locally manufactured shank recorded the highest value for this trait, which amounted to (0.115336) m², while the conventional shank recorded the lowest value for this trait, which amounted to (0.11705) m².The reason for this is that the locally manufactured shank achieved the highest values for both the disruption width at the surface and the critical depth from the surface, which are considered among the components of the law of the distribution area, meaning that by increasing them, the area of the distribution area increases and this is consistent with what was reached by (Oday, b 2018) and (Al Hanoush) , 2020). The table indicates the significantly excelled of the locally manufactured share in recording the highest value for the trait of the distribution area, which amounted to (0.110956) m², while the traditional share recorded the lowest value for this trait , which amounted to (0.106086) m².The reason for this is due to the fact that the locally manufactured share has a surface that is wider than the traditional share , which led to an increase in the distribution area, which in turn led to an increase in the distribution area, and this is consistent with (Ramadhan, 2014) and (Tahir & Jeejo, 2019). The table shows that the effect of the angle of penetration was significant on the trait of the distribution area, where the angle 40º recorded the highest value for this trait, which amounted to

(0.113360) m², while the angle of 50º recorded the lowest value for this trait , which amounted to (0.103682) m². The reason for this is that the increase in the angle of penetration led to a decrease in the value of both the disruption width at the surface and the critical depth from the surface, which also led to an increase in the compaction of the raised soil at the top of the foot with the uncultivated soil as well as on the sides. With his findings (Abdul-Jabbar, 2011). The table indicates that there are significant differences in the bi-interaction between the type of shank and the type of share in the character of the area of the plowing section according to Duncan test, although the calculated F value is less than the tabular F value, as the highest value was recorded at the locally manufactured shank and share, which amounted to (0.118516) m² While the conventional shank and share recorded the lowest value for this trait, which amounted to (0.100015) m², and the reason for this is due to the shank shape and share as mentioned previously. The table shows the significant excelled of the locally manufactured shank with a penetration angle of 40º in recording the highest value of the distribution area trait, which amounted to (0.122382) m² While the conventional shank with the angle of penetration 50º recorded the lowest value for this trait, which amounted to (0.099073) m², and the reason is due to the value of the angle of penetration as mentioned previously. The table shows at the interaction between the type of share and the angle of penetration, and although the calculated F value is less than the tabular F value, Duncan's test showed that there were significant differences in the trait of the distribution area, The highest value for this trait was recorded with the locally manufactured share with angle 40º, which amounted to (0.117766) m², while the traditional share with the penetration angle 50º recorded the lowest value for this trait, which amounted to (0.103218) m², and the reason for this is due to the shape and design of the share and the angle of penetration as mentioned Previously . It is noted from the table that there are significant differences at the triple interference between the type of shank , the type of share and the angle of penetration in the traits of the distribution area according to Duncan's test, although the calculated F value is less than the tabulated F value. The highest value of this trait was recorded at the locally manufactured shank and share with the penetration angle of 40º, which amounted to (0.127724) m², while the lowest value of this trait was recorded at the conventional shank with the locally manufactured share with the penetration angle of 50º, which amounted to (0.098982) m² for the reasons mentioned previously.

Table (4) The effect of the studied factors and their interactions on the trait of the distribution area (m2)

shank type	Share type	angle of penetration		The interaction between the shank and share	
		40	50		
traditional	traditional	0.100868 c D	0.099163 c d	0.100015 b	
	manufactured	0.107808 b c d	0.098982 d	0.103395 b	
manufactured	traditional	0.117040 b	0.107273 b c d	0.112157 A	
	manufactured	0.127724 A	0.109309 b c	0.118516 A	
The interaction between the shank and the angle	traditional	0.104338 b c	0.099073 c	average shank type	0.101705 b
	manufactured	0.122382 A	0.108291b		0.115336 A
The interaction between the share and the angle	traditional	0.108954 b	0.103218b	average share type	0.106086 b
	0.117766 A	0.117766 A	0.104146b		0.110956 A

average angle of penetration	**0.113360 A**	**0.103682b**	

The lower value is the better.

Conclusion:

We conclude through this study that it is possible to use the locally manufactured shank and share with a penetration angle of 40º in the event that farmers have a high power source because this combination achieved the best values for the distribution area.

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