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Using the patterns of distribution of chisel plow tines with different depths and speeds and its effect in some field performance indicators.

Abdulhamid Sadullah Abdulkhadir Majid **Mothana Abed Al-malik Noori Al-jarrah**
Department of Agricultural Machinery and equipment, College of Agriculture and Forestry, University of Mosul, IRAQ.
*Corresponding Author: abdulhameed.22agp95@student.uomosul.edu.iq.

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ABSTRACT

This research study included evaluating the effect of patterns of distribution of chisel plow tines on field performance at different operating factors by studying three factors. The first is patterns of distribution of the chisel plow tines at three levels (3-4-4), (2-4-5) and (2-5-4) and the second factor is the depth of tillage at two levels (10-12) cm and (15-17) cm and third factor is the speed of work at two levels (3.21) km/h and (4.72) Km h^{-1}. and the effect of this is on the following characteristics (drawbar power, slip ratio, actual productivity, energy consumed, specific resistance to traction, specific energy). Used randomized completely block design (RCBD) with the split – split plot Designs system in implementing the experiment, Duncan's multiple range test was used to find significant differences between the averages of the treatments at the probability level (0.05). The results showed that the second distribution pattern was significantly superior, as it recorded the lowest values for the drawbar power , slip ratio, and energy consumed, while the third distribution pattern was significantly superior in achieving the lowest values for the characteristics of specific resistance to traction and specific energy, and achieved a plowing depth of (10-12) cm significant superiority by recording the lowest values for the characteristics of drawbar power , slip ratio, and energy consumed, and the highest values for actual productivity, while the depth (15-17) cm was significantly superior by recording the lowest values for the characteristics of specific resistance to traction and specific energy and the speed (3.21) km/h was significantly superior by achieving the lowest values for the characteristics of drawbar power, slip ratio, energy consumed, specific resistance to traction, and specific energy, while the speed (4.72) km/h was significantly superior by achieving the highest values for the value characteristic of actual productivity.

Keywords: distribution patterns of plow tines, drawbar power, slippage, actual productivity, consumed energy, specific resistance to traction and specific energy.

INTRODUCTION

Agricultural practices require the use of a wide range of agricultural machinery and equipment for various crops cultivation. This starts with primary soil preparation equipment through smoothing and levelling machines, sowing equipment, plantings, fertilization, weed control, irrigation systems and harvesting machines. In order to be able to use these machines and equipment with the highest efficiency, the necessary energy must be provided to operate these implements well and try to take advantage of the available energy. The maximum benefit with the lowest energy waste and loss, on the other hand, agricultural machinery and equipment must be in a balance to cover the cultivated areas and the actual need for energy saving, which reflects positively on farmer's net profit. To achieve the best benefit from the agricultural equipment and machinery that is used, the appropriate machine must be chosen and placed in the appropriate place and ideally exploited to obtain the highest possible productivity of the machine. The tillage process consumes a large part of the total available energy in the farm, especially the soil initial tillage, and the used working width of the machine and the tillage speed depends on the amount of available energy in the field. This affects the field production directly and the required energy to operate the Chisel plow in the primary tillage is less compared to the use of rotary plows with an increase in the speed of tillage [1]. [2] Studied the effect of tillage depth and forward speed on pulling power of mouldboard plough. Where increasing the depth from (20-15) cm to (25-20) cm lead to increase the towing power from (8.053) kW to (8.841) kW. This increased the working speed from (2.22 to 3.22 and 5.85) km / h, and led to an increase in the towing power from (4.344 to 6.896 and 14.101) kW for the three speeds respectively. [3] showed that, the proper agricultural practices require a slippage rate for 4 Wheel Drive Tractor from (8 to 12) % and not exceed (15) % due to the importance of slippage in determining field performance and fuel consumption. [4] stated that, the slippage rate increases with tillage depth increasing and the increase in front speed. [5] explained in the effect of tractor front speed and the tillage depth on some soil physical properties, where speed increasing led to an increase in actual productivity because the speed is one of the components of calculating actual productivity and attributed the reason for this to an increase in the soil disturbed, thus increasing the actual productivity. [6] found that, the modified four-row chisel plough record a greater reduction in energy consumption compared to two-row three-row chisel plough. Where the specific resistance was affected by the work depth for each of plough types as it decreased with depth increasing because the plowed area increased more than the pulling force with increasing depth. A study of tillage methods' effects on the requirements of fragmentation energy under different operating conditions in alluvial mixture soils [8] showed that the specific energy decreased with speed reduction and tillage depth increase.

-The experiment aims to choose the best tines distribution pattern that achieves the lowest power and energy requirements during the tillage process.

Materials and methods:

The experiment was conducted in December 2023 at an agricultural field in Telkaif district, north of Mosul city. The field was cultivated with wheat in previous season; table (1) shows the field soil properties. The experiment designed with a randomized complete block design (RCBD) under the system of split - split plot design [9]. Duncan's multiple range test was used to find significant differences between the averages of the coefficients at the probability level (0.05). For pulling force measurement an electronic pulling force device was used with a maximum (5000) kg reading. The plough manufactured in a way where attachment locations can be changed on the main structure. This gave a possibility of changing the tines patterns distribution, which was one of studied factors in the experiment which consists (11) tines with a working width (2475) mm. The used tractor type was Hattat 285 S as a source of power (front tractor), while for rear tractor type Massey Ferguson 290 been used, for plough attachment. The pulling force measuring device was placed between the two tractors. The experiment includes three factors; first factor was tines patterns distribution as in Figure (1) with three conventional levels (3-4-4), (2-4-5), (2-5-4) the distance between one tine and another in the same row (225) mm and the distance between row and another (400) mm and a tine with two pointed ends was used.

While, the second factor was tillage depth of with two levels (12-10) cm and (17-15) cm, and the third factor tillage speed with two levels (3.21) km/h and (4.72) km/h.

Table (1) shows the soil texture, some physical characteristics, and the moisture content of the soil

Silt%	Clay%	Sand%	Soil texture
36.25	27.7	36.05	Loamy clay
Depth Cm	Bulk density g/ cm^3	Soil penetration resistance KN m^{-2}	Moisture content (%)
0-10	1.20	478.989	17-18
10-20	1.41	513.202	

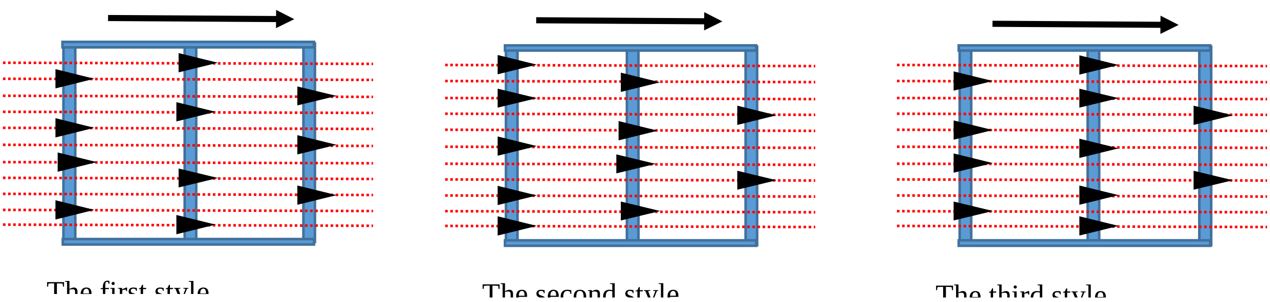

Figure (1) Tines patterns distribution the distance between one tine and another in the same row (225) mm and the distance between row and another (400) mm and the tine used has two pointed ends.

Studied traits:

1- **Drawbar power (kW)**: It is the produced power from the multiplication of required pulling force by the tractor to pull a machine or etc. by the actual speed which produced by pulling that machine, according to the equation [10]:

$Pt = Ft \times Vp$

Where;

Pt: drawbar power (kW)

Ft: pulling force (kN)

Vp: actual speed (m/s)

$Vp = (L / Tp)$

Where;

Vp: actual speed (m/s)

L: distance during plowing (m)

Tp: plowing time (s)

2- **Slippage ratio (%):** It is the reduction in driving wheels round numbers after loading compared to the driving wheels round numbers before loading for a specific distance, found from the equation [11]**.**

$Sp = (Vt – Vp / Vt) \times 100$

Where:

Sp: Slippage ratio (%)
Vt: theory speed (km/h)
Vp: actual speed (km/h)

3- **Actual productivity (ha/h):** it is the actual work produced by the machine during a period of time, found from the equation [12]

$EFC = Vp \times 1000 \times Wp \times EF / C$
Where:
EFC: Actual productivity (ha/h)
Vp : actual speed (km/h)
Wp: actual width (m)
EF: Field Efficiency assumed as (0.85) for chisel plough [13]
C: Invested unit area (10000 m^2/ha)

4- **Consumed Energy:** It is the power that is consumed by the tractor during plough pulling while it plowing a specific area, found from the equation [1]:

$CE = Pt \times 3.6 / EFC$
Where:
CE: Consumed Energy (MJ/ha)
Pt: pulling power (kW)
EFC: Actual productivity (ha/h)

5- specific resistance to traction (KN m^{-2}): It is the ratio between the required force for towing to the area of the plowed soil section**,** found from the equation [14]:

$SRT = Ft / Wp \times Dp$
Where:
SRT: (KN m^{-2})
Ft: pulling force (kn)
Wp: actual plowing width (m)
Dp: actual plowing depth (m)

6- Specific Energy (KJ/m^3): It is the required energy for plowing a unit volume of soil, this found by dividing the towing power by the disturbed soil volume [15]:

$SEV = Pt \times 3600 / SDV$
Where:
SEV: Specific Energy (KJ/m3)
Pt: pulling power (kW)
SDV: disturbed soil volume (m3/h)
$SDV = Vp \times Dp \times Wp \times 1000$
Where:
SDV: disturbed soil volume (m3/h)
Vp: actual speed (km/h)
Dp: actual plowing depth (m)
Wp: actual plowing width (m)

Results and discussion

1- Drawbar power:

Table (2) shows that, there is a significant effect of tines patterns distribution characteristic of drawbar power, as the second distribution pattern (2-4-5) significantly exceeded the first type (3-4-4) in achieving the lowest value of the drawbar power (10.97) kW, which did not differ significantly from the third type (2-5-4), which achieved a drawbar power of (11.01) kW. In contrast, the first type achieved the highest value of the achieved a drawbar power of (11.30) kW. It is noted that the second type recorded the lowest value of the achieved a drawbar power, followed by the pattern The third and then the first traditional style and The reason for this may be due to the good and consistent distribution of tines in the second type (2-4-5), which leads to a regular distribution of the forces applied to the tines, thus giving it less pulling capacity.

The same table also shows a significant effect of tillage depth on characteristic of the drawbar power, as the first depth exceeds (10-12) cm, significantly achieving the lowest value of drawbar power (9.59) kW. While, the second depth (15-17) cm achieved a drawbar power of (12.60) kW and it is found that the towing power has increased with increasing tillage depth. The reason for this is due to the increase in the force required for drawbar power with increasing plowing depth to increase the volume of disturbed soil with increasing depth, which increases the necessary force for pulling and this Increasing required drawbar power, this was confirmed by [16].

It is noted from the table that there is a significant effect of the front speed on drawbar power, as the first front speed (3.21) km/h significantly exceeded in achieving the lowest drawbar power of (9.00) kW. In contrast, the second speed achieved (4.72) km / h a drawbar power of (13.18) kW It is noted that the drawbar power has increased with increasing speed due to the increase in the force required for pulling with the increase in the front speed and that the speed is one of the components of calculating the drawbar power increases The required power to do so and this is what he reached [2]. From the observation of the table, it is clear that there is no significant effect of the interaction between studied factors in the characteristic of the drawbar power.

Table (2) Effect of the studied factors and their interactions on drawbar power (kW)

Tines distribution patterns	tillage depth (cm) 10-12 15-17	front speeds (km/h) 3.21	4.72	Interaction between distribution patterns and tillage depth	
First style	10-12	7.80	11.63	9.72 d	
	15-17	10.56	15.22	12.89 a	
Second style	10-12	7.77	11.40	9.58 e	
	15-17	10.01	14.69	12.35 c	
Third style	10-12	7.65	11.29	9.47 f	
	15-17	10.24	14.85	12.55 b	
Interaction between distribution patterns and front speeds	First style	9.18	13.43	Means of tines distribution patterns	11.30 a
	Second style	8.89	13.05		10.97 b
	Third style	8.95	13.07		11.01 b
Interaction between tillage depth and front speeds	10-12	7.74 d	11.44 b	Means of tillage depth	9.59 b
	15-17	10.27 c	14.92 a		12.60 a
Means of front speeds		9.00 b	13.18 a		

• The lowest value is the best.

2- Slippage ratio:

Table (3) shows the existence of a significant effect of time distribution patterns in the slippage ratio, where the second distribution pattern had a significant influence compared to the first pattern in recording the lowest value of the slippage ratio of (5.88) %. Which did not differ significantly from the third pattern, which achieved a slippage rate of (6.19) %, while the first pattern achieved the highest value of the slippage ratio of (6.97) %. It is noted that the second pattern achieved the lowest slippage ratio, because the second pattern recorded the lowest comparative drawbar power. In the third and first modes, which led to a decrease in the tractor load and then a decrease in the slippage ratio.

The table shows that the slippage ratio is affected significantly by the tillage depth, as the first tillage depth is significantly greater in recording the lowest value of the slippage ratio (5.23) %, while the second depth recorded the highest value of the slippage rate of (7.46) %. It is noted that the slippage increased with increasing depth, because the increase in the tillage depth led to an increase in the strength of the draft and thus increased the percentage of slippage, this is confirmed by [17].

The table also shows that the front speed affected slippage ratio significantly, as the first speed record significant value compared to the second speed, achieving the lowest value of the slippage ratio (5.88) %, while the second speed recorded the largest value of the slippage ratio of (6.81) %. This slippage is consistent with his findings of [4].

There were no significant differences between interactions of tillage distribution, tillage depths and front speeds in the slippage ratio.

Table (3) effect of the studied factors and their interactions on slippage ratio (%)

Tines distribution patterns	tillage depth (cm) 10-12 15-17	front speeds (km/h) 3.21	4.72	Interaction between distribution patterns and tillage depth	
First style	10-12	5.91	6.50	6.20 b	
	15-17	6.85	8.62	7.73 a	
Second style	10-12	4.25	4.73	4.49 c	
	15-17	6.85	7.70	7.27 a	
Third style	10-12	4.77	5.23	5.00 c	
	15-17	6.64	8.12	7.38 a	
Interaction between distribution patterns and front speeds	First style	6.38	7.56	Means of tines distribution patterns	6.97 a
	Second style	5.55	6.21		5.88 b

	Third style	5.70	6.67		6.19 b
Interaction between tillage depth and front speeds	10-12	4.98 d	5.48 c	Means of tillage depth	5.23 b
	15-17	6.78 b	8.14 a		7.46 a
Means of front speeds		5.88 b	6.81 a		

• The lowest value is the best.

3- Actual productivity

Table (4) shows that tines distribution patterns did not have a significant impact on the actual productivity, as the second tines distribution pattern recorded the highest value of actual productivity of (0.768) ha/h, while the first distribution pattern recorded the lowest value of actual productivity (0.764) ha/h. Perhaps the reason behind that is due to the low draw power compared to the first and third types, which led to an increase in the actual speed, which is one of the productivity compounds.

The table also shows that tillage depth has a significant impact on the actual productivity, as the first tillage depth exceeds significantly, achieving the highest actual productivity of (0.773) ha/h. While the second tillage depth recorded an actual productivity of (0.760) ha/ h, this noted that productivity has increased with the reduction of depth, and the reason for this is that reducing the depth led to an increase in the actual speed and thus increased productivity because the speed is one of the components of the actual productivity calculation and this in consistent with [18] finding.

It is clear from the same table that the front speed has a significant impact on actual productivity, as the second speed achieved the highest value of the actual productivity (0.908) ha/h. significant increase of first speed, which achieved the lowest value of the actual productivity (0.625) ha/h, and it is noticeable that the actual productivity increases with increasing speed because the speed is one of the parameters of calculating the actual productivity, and this confirmed by [19].

It is clear that there are no significant differences in the interactions between the studied factors in actual productivity.

• The highest value is the best.

Table (4) Effect of the studied factors and their interactions on Actual productivity (ha/hour)

Tines distribution patterns	tillage depth (cm)	front speeds (km/h)		Interaction between distribution patterns and tillage depth	
	10-12 15-17	3.21	4.72		
First style	10-12	0.625	0.911	0.768	
	15-17	0.622	0.898	0.760	
Second style	10-12	0.632	0.924	0.778	
	15-17	0.617	0.900	0.759	
Third style	10-12	0.631	0.916	0.774	
	15-17	0.624	0.897	0.761	
Interaction between distribution patterns and front speeds	First style	0.624 d	0.912 a		0.764
	Second style	0.624 cd	0.907 b	Means of tines distribution patterns	0.768
	Third style	0.628 c	0.917 a		0.767
Interaction between tillage depth and front speeds	10-12	0.629 c	0.917 a	Means of tillage depth	0.773 a
	15-17	0.621 d	0.898 b		0.760 b
Means of front speeds		0.625 b	0.908 a		

4- Consumed energy

Table (5) shows a significant impact of tine distribution patterns on consumed energy, where the second pattern had a significant influence compared to the first type by achieving the lowest value of consumed energy (51.44) MJ/ha. This did not differ significantly from the third type, which achieved a consumed energy (51.65) MJ/ha, while the first type achieved the highest value of consumed energy (53.24) MJ/ha. It is noted that the second type recorded the lowest consumed energy due to the achievement of the second type with the lowest towing power, the highest productivity, and reduced consumed energy.

It is noted from the table that tillage depth has a significant impact on consumed energy, as the first depth achieved the lowest value of consumed energy (44.58) MJ/ha, while the second depth recorded the highest consumed energy amounted by (59.64) MJ/ha and it is found that the consumed energy increased with increasing tillage depth due to the increase in required towing power as a result of increasing the depth and this is consistent with [20].

The table also displays a significant effect of front speed on the consumed energy, as the first speed significantly outperformed the second speed by achieving the lowest value of the consumed energy (51.88) MJ/ha. While the second speed achieved the highest value of consumed energy (52.34) MJ/ha and it is noticeable that the consumed energy increases with the increase in speed because the increase in speed leads to an increase in the towing power that enters into the calculation of the consumed energy and this is consistent with [21] findings.

It is also clear that the interaction between the studied factors did not significantly affect consumed energy

Table (5) Effect of the studied factors and their interactions on consumed energy (MJ/ha)

Tines distribution patterns	tillage depth (cm)	front speeds (km/h)		Interaction between distribution patterns and tillage depth	
	10-12 15-17	3.21	4.72		
First style	10-12	44.91	45.96	45.44 d	
	15-17	61.10	61.01	61.05 a	
Second style	10-12	44.26	44.40	44.33 e	
	15-17	58.35	58.74	58.54 c	
Third style	10-12	43.62	44.37	43.99 e	
	15-17	59.05	59.58	59.31 b	
Interaction between distribution patterns and front speeds	First style	53.00	53.49	Means of tines distribution patterns	53.24 a
	Second style	51.30	51.57		51.44 b
	Third style	51.33	51.97		51.65 b
Interaction between tillage depth and front speeds	10-12	44.26	44.91	Means of tillage depth	44.58 b
	15-17	59.50	59.78		59.64 a
Means of front speeds		51.88 b	52.34 a		

• The lowest value is the best.

5- Specific resistance to traction:

Table (6) shows a significant effect of tines distribution patterns in specific resistance to traction, as the third distribution pattern significantly outperformed the first and second types by achieving the lowest value of the specific resistance (31.79) KNm^{-2}. While the first type achieved the highest value of the specific resistance (34.12 KNm^{-2} while the second type achieved (33.13) KNm^{-2} It is noted that the third pattern achieved the lowest value of the specific resistance, followed by the second type and then the first traditional pattern and may be due to the reason This is due to the type of tines distribution pattern that reduced the specific resistance to traction from a decrease in the drawbar power and an increase in the area of disturbed soil section.

The table also shows that tillage depth has a significant impact on the specific resistance to traction, as it exceeds the second depth significantly by recording the lowest value of the specific resistance (32.19 KNm^{-2}, while the first depth recorded the highest value of specific resistance (33.84) KNm^{-2} and it is noted that the increase in depth led to a decrease in the specific resistance, because the plowed area increased more than the increase in the drawbar power with the increase in depth, which led to a decrease in the specific resistance to traction, and this is consistent with [7].

It is noted that the front speed affected significantly on specific resistance as the first speed achieved the lowest value specific

resistance (32.78 KNm^{-2} compared to the second speed, which achieved the highest value for specific resistance (33.25) KNm^{-2}.It is noticeable to increase the specific resistance by increasing the front speed and the reason for this is that the disturbed area of the soil was not affected by the front speed, but the increase in the drawbar power led to an increase in specific resistance and this is consistent with [22].
We also note that the specific resistance to traction was not significantly affected by the interaction between tine distribution patterns, tillage depths and front speed.

Table (6) effect of the studied factors and their interactions on specific resistance to traction (KNm^{-2})

Tines distribution patterns	tillage depth (cm)	front speeds (km/h)		Interaction between distribution patterns and tillage depth	
	10-12 15-17	3.21	4.72		
First style	10-12	34.42	35.57	35.00	
	15-17	33.09	33.42	33.25	
Second style	10-12	34.10	33.98	34.04	
	15-17	32.25	32.19	32.22	
Third style	10-12	32.33	32.64	32.48	
	15-17	30.50	31.71	31.10	
Interaction between distribution patterns and front speeds	First style	33.75 b	34.50 a	Means of tines distribution patterns	34.12 a
	Second style	33.18 c	33.08 c		33.13 b
	Third style	31.41 e	32.17 d		31.79 c
Interaction between tillage depth and front speeds	10-12	33.61	34.06	Means of tillage depth	33.84 a
	15-17	31.95	32.44		32.19 b
Means of front speeds		32.78 b	33.25 a		

• The lowest value is the best.

6- Specific energy:

It is noted from Table (7) that there is a significant impact of the tines distribution patterns on specific energy. Where third type significantly exceed the first and second types by achieving the lowest value of specific energy (31.82) kJ/ m^3. While the second type achieved a significant value of specific energy (33.02) kJ/m^3, compared to the first type. Which achieved the highest value of specific energy (34.05) kJ/m^3 it noted that the lowest value of specific energy achieved by the third type as it recorded the highest value of disturbed soil volume this cause a decrease in specific energy.
The table shows a significant impact of tillage depth on specific energy, as the second depth achieved significant value of specific energy (32.12) KJ/m^3, compared to the first depth, which achieved the highest value of the specific energy (33.81) KJ/m^3 and it is found that the specific energy has decreased with the increase in tillage depth and the reason for this is that the increase in value of disturbed soil volume is greater than the increase in the towing power and this is consistent with [23].

It is also clear that there are significant differences between front speeds in terms of quality energy, as the first speed significantly exceeds the second speed by recording the lowest value of specific energy (32.81) KJ/m^3. While the second speed achieved the highest value of specific energy (33.11) KJ/m^3 it noted that the increase in speed led to an increase in specific energy due to the fact that the increase in speed leads to an increase in the speed of untilled soil parts, thus increasing the crash of those untilled soil parts in front of them and not plowed Resistance to the movement of the plow, which leads to an increase in the specific energy and this is consistent with [24].
It is also clear that the interaction between the tines distribution patterns, tillage depth and the front speed had a significant impact on specific energy, as the treatment of the third distribution pattern with the second depth and the first speed significantly increased compared to the other transactions by recording the lowest value of specific energy (30.53) KJ/m^3, while the treatment of the first type with the first depth and the second speed recorded the highest value of specific energy (35.18) KJ/m^3.

Table (7) Effect of the studied factors and their interactions on specific energy (KJ/m^3)

Tines distribution	tillage depth (cm)	front speeds (km/h)	Interaction between

patterns	10-12	15-17	3.21	4.72	distribution patterns and tillage depth	
First style	10-12		34.46 b	35.18 a	34.82	
	15-17		33.13 cd	33.45 c	33.29	
Second style	10-12		34.17 b	33.99 b	34.08	
	15-17		32.26 e	31.66 f	31.96	
Third style	10-12		32.34 e	32.69 e	32.51	
	15-17		30.53 g	31.72 f	31.12	
Interaction between distribution patterns and front speeds	First style		33.79 b	34.31 a	Means of tines distribution patterns	**34.05 a**
	Second style		33.22 c	32.82 d		**33.02 b**
	Third style		31.43 f	32.20 e		**31.82 c**
Interaction between tillage depth and front speeds	10-12		33.66	33.95	Means of tillage depth	**33.81 a**
	15-17		31.97	32.27		**32.12 b**
Means of front speeds			32.81 b	33.11 a		

• The lowest value is the best.

Conclusions:

-The second distribution pattern (2-4-5) recorded the lowest values for the characteristics of (drawbar power, slippage ratio, energy consumed) and the highest value for the actual productivity characteristic**.**

-The third distribution pattern (2-5-4) recorded the lowest values for the characteristics of (specific resistance, specific energy).

-The third distribution type treatment with the second depth and the first speed achieved significant superiority over the rest of the treatments by recording the lowest value of specific energy.

-We recommend using the speed (3.21) km/h in order to achieve the best values for the drawbar power, slip ratio, energy consumed, specific resistance, and specific energy**.**

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استخدام المحراث الحفار بأنماط مختلفة لتوزيع الأسلحة وتأثير ذلك في بعض مؤشرات الأداء.

عبدالحميد سعدالله عبدالقادر مجيد مثنى عبدالمالك نوري الجراح
قسم المكائن والآلات الزراعية, كلية الزراعة والغابات , جامعة الموصل, العراق.

الخلاصة

نفذت هذه الدراسة البحثية لتقييم تأثير أنماط توزيع أسلحة المحراث الحفار في الأداء الحقلي عند عوامل تشغيل مختلفة من خلال دراسة ثلاثة عوامل ، الأول أنماط توزيع الأسلحة بثلاثة مستويات (***3-4-4***) ، (***2-4-5***) و(***2-5-4***) والعامل الثاني عمق الحراثة بمستويين (***10-12***) سم و(***15-17***) سم والعامل الثالث سرعة العمل بمستويين (***3.21***) كم/ساعة و(***4.72***) كم/ساعة وتأثير ذلك في الصفات التالية (قدرة السحب ، نسبة الانزلاق ، الإنتاجية الفعلية ، الطاقة المستهلكة ، المقاومة النوعية للسحب والطاقة النوعية) استخدم تصميم القطاعات العشوائية الكاملة مع نظام الالواح المنشقة – المنشقة في تنفيذ التجربة وتم استخدام اختبار دنكن متعدد المدى لإيجاد الفروقات المعنوية بين متوسطات المعاملات عند مستوى احتمالية (***0.05***). أظهرت النتائج تفوق نمط توزيع الأسلحة الثاني معنويا اذ سجل اقل قيم لقدرة السحب ونسبة الانزلاق والطاقة المستهلكة بينما تفوق نمط التوزيع الثالث معنويا في تحقيق اقل قيم لصفات المقاومة النوعية للسحب والطاقة النوعية وحقق عمق الحراثة (***10-12***) سم تفوقا معنويا بتسجيل اقل قيم لصفات قدرة السحب ونسبة الانزلاق والطاقة المستهلكة واعلى قيم للإنتاجية الفعلية في حين تفوق العمق (***15-17***) سم معنويا بتسجيل اقل قيم لصفات المقاومة النوعية للسحب والطاقة النوعية وسجلت السرعة (***3.21***) كم/ساعة تفوقا معنويا بتحقيق اقل قيم لصفات قدرة السحب ونسبة الانزلاق والطاقة المستهلكة والمقاومة النوعية للسحب والطاقة النوعية في حين تفوقت السرعة (***4.72***) كم/ساعة معنويا بتحقيق اعلى قيم لصفة قيمة للإنتاجية الفعلية .

<u>الكلمات المفتاحية</u>: أنماط توزيع أسلحة المحراث، قدرة السحب، الانزلاق، الإنتاجية الفعلية، الطاقة المستهلكة، المقاومة النوعية للسحب والطاقة النوعية.