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المجلة العراقية لبحوث السوق
وحماية المستهلك

PERFORMANCE OF THE SAKALAK SK-FM SEED DRILL IN SILTY CLAY LOAM SOILS

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ABSTRACT

The experiment was conducted in agricultural fields of the Agricultural Research Department in Abu-Ghraib region during November 2022 to study three levels of depths: 2, 4, and 6 cm, and three speed 5, 6.5, and 7.5 km h^{-1} on the performance of the fertilized seed drill, SAKALAK SK-FM, with the Renault tractor as a mechanical unit in the silty clay loam soil. The following characteristics were studied: the percentage of slippage, actual field productivity, fuel consumption, and number of plants per square meter. The experiment was conducted using a randomized complete block design, with split plot arrangement with three replications. The depth allocated to the main plots, and the forward speed allocated to the sub-plots. The results indicated that highest slip ratio7.06% and pulling force 12 KN at the interaction between depth 6 cm and forward speed 7.5 km/h , the lowest slip ratio 3.55 and pulling force 8 KN at the interaction between depth 2 cm and forward speed 5 km/h. The lowest fuel consumption 6.39 and the number of plants per square meter 4.33 at the interaction between depth 2 cm and forward speed 7.5 km/h, The highest fuel consumption 10 and the number of plants per square meter 5.67at the interaction between depth 2 cm and forward speed 5 km/h.

Keywords: Actual Field productivity, fuel consumption, Seed drill, Slippage, Pulling force.

اداء الباذرة SAKALAK SK-FM في الترب المزيجة الطينية الغرينية

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الخلاصة

نفذت التجربة في أحد الحقول الزراعية التابعة لدائرة البحوث الزراعية في منطقة ابي غريب في شهر الحادي العاشر سنة ٢٠٢٢ لغرض دراسة ثلاث مستويات من الأعماق ٢ و٤ و٦ سم وثلاث مستويات من السرع المتمثلة بالقيم ٥ و٦,٥ و٧,٥ كم.ساعة-١ في أداء الباذرة المسمدة الزارعة SAKALAK SK-FM مع الجرار رينلت كوحدة ميكنية في الترب المزيجة الطينية الغرينية وتم دراسة الصفات التالية: النسبة المئويه للانزلاق، الإنتاجية الحقلية الفعلية، الوقود المستهلك وعدد النباتات في المتر المربع نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة وبترتيب الالواح المنشقة وبثلاث مكررات. اشارت النتائج الى أعلى نسبة انزلاق ٧,٠٦٪ وقوة سحب ١٢ كيلو نيوتن سجلت عند التفاعل بين العمق ٦ سم والسرعة الأمامية ٧,٥ كم/ساعة، وأدنى نسبة انزلاق ٣,٥٥٪وقوة سحب ٨ كيلو نيوتن سجلت عند تداخل بين العمق ٢ سم والسرعة الأمامية ٥ كم/ساعة . أقل استهلاك للوقود ٦,٣٩ وعدد النباتات لكل متر مربع ٤,٣٣ سجلت عند تداخل بين العمق ٢ سم والسرعة الأمامية ٧,٥ كم/ساعة، وأعلى استهلاك للوقود ١٠ وعدد النباتات لكل متر مربع ٥,٦٧ سجلت عند التفاعل بين العمق ٢ سم وسرعة أمامية ٥ كم / ساعة.

الكلمات المفتاحية: الإنتاجية الحقلية استهلاك الوقود، عدد النباتات، الانزلاق، قوة السحب.

INTRODUCTION

Humans began using modern agricultural machinery and their accessories in order to keep up with technological advancements in various fields. When designing agricultural machinery, consideration is given to minimizing energy consumption while maximizing productivity, in order to provide the highest possible fuel efficiency. Even slight differences in fuel consumption should be taken into account, especially when working on large areas. **(Frank, *et al*., 2012).** Seed drill is specialized agricultural equipment used for seed planting. The process of sowing grains is an important agricultural operation that follows soil preparation processes, including plowing, harrowing, and seedbed preparation. Seeds can be sown manually, which is one of the oldest methods of sowing and is still widespread in many regions of Iraq, especially in small fields owned by farmers. However, this method is not efficient in evenly distributing seeds and requires significant time and labor, resulting in additional costs in crop production and significant loss in yield due to delayed planting. The second method used in sowing is the use of mechanical seed drill, which has become widely popular in recent years, particularly for large areas. These mechanical seeders have shown positive results in terms of speed and minimizing seed wastage, making them indispensable in large-scale agricultural production operations. Similarly, the fertilization process has shown high economic success when using fertilization equipment to increase agricultural productivity. Fertilization equipment often has a similar design to seed drill, and combined seed drill and fertilizers have been used in one vehicle **(Al-Tahan & Al-Na'mah, 2000).**

Corn is considered one of the most important crops worldwide due to its multiple uses, allowing it to thrive in a wide range of agricultural environments (**Al-Aridhee & Mahdi, 2022).** Corn is a strategic crop that plays a significant role in ensuring food security in Iraq and contributes to the development of agro-industries. It also plays a crucial role in animal production by providing green and concentrated fodder (**Al-Janabi, *et al*., 2023**), especially with the increasing population. The projected population increase, currently at 7.2 billion, is expected to reach approximately 9.2 billion by 2050 **(Tawfiq, 2019)**.

Study Objective

To examine the performance of the SAKALAK SK-FM seed drill and find the optimal combination of depth and speed with the lowest overall costs, as well as to provide recommendations through the result obtained to achieve the best performance.

MATERIALS AND METHODS

Experiment Field Implementation

The experiment was conducted at the Abu Ghraib Research Station, Agricultural Research Department, Ministry of Agriculture in Baghdad during the 2022/2023 growing season. Corn variety (Al-Maha) was planted at the experimental site due to the availability of suitable water and soil for cultivation. The soil texture at the site was a silty clay loam, and the location was characterized by a moderate climate according to the Agricultural Meteorological Center, Ministry of Agriculture, Iraq (2022). The purpose was to study three levels of depths and three levels of speeds and evaluate the performance of the Spanish-made SAKALAK SK-FM seed drill.

Table (1): Fertilized seed specifications.

machine type	**Seed Drill**
the weight	**1020 kg**
Tank number	**4**
Tank capacity	**25 kg**
Fertilization tank number	**2**
Composting tank capacity	**200kg**
Number of bottles for sowing and fertilizing	**4**
The distance between the vials	**75cm**
Seed drop mechanism	**4 perforated discs that differ from one crop to another The number of holes on the disc is 20**
origin	**Spanish**
manufacturing year	**2019**

Characteristics Studied in the Experiment and Calculation Methods:
Slippage Percentage:

It is calculated using the following equation: **(Laibi & Al- Ani, 2022).**

$$SP = \frac{VT-VP}{VT} X\ 100 \quad \text{.................. (1)}$$

Where:
SP = Slippage percentage (%)
VT = Theoretical speed without load (km/h)
VP = Operational speed with load (km/h)
The theoretical speed (km/h) is calculated by dividing the distance traveled by the theoretical

time, using the following equation:

$$VT = \frac{D}{Tt} X\ 3.6 \quad \text{..................... (2)}$$

Where:
D = Length of the plowed line (m)
Tt = Theoretical time without load (seconds)

The operational speed (km/h) is calculated using the following equation:

$$VP = \frac{D}{TP} X\ 3.6 \quad \text{..................... (3)}$$

Where:
D = Distance of the plowed line (m)
Tp = Operational time with load (seconds)

Fuel Consumption Rate:
The fuel consumption rate is calculated using the following equation**: (Al-Jarrah, 1998).**

$$QF = \frac{Qd \times 10000}{D \times WP \times 1000} \quad \text{..................... (4)}$$

Where:
QF = Fuel consumption per hectare (liters/hectare)
Qd = Fuel consumption during treatment (milliliters)
D = Length of the treatment (meters)
WP = Actual plow width (meters).

Pulling Force:
It is measured using the following equation: **(Laibi, 2022)**
FT = Fpu - FRM.......... …………. (**5**)
Where:
FT = Pulling force (kN)
Fpu = Pulling force where the plow almost touches the ground
FRM = Rolling resistance where the plow almost touches the ground

Number of Plants per Square Meter:
The number of plants per square meter was calculated after germination, randomly within each treatment, and the average was taken.

RESULTS AND DISCUSSION

Slippage Percentage (%)

Table (2) shows the effect of both each of the depth and forward speed of the tractor on the slippage percentage. It is evident that when increasing the working depth from 2 to 4 and then to 6 cm resulted in an increase in the slippage percentage from 4.10 to 4.75 and then to 6.10%. The reason for this increase is attributed to the fact that increasing the plowing depth increases the load on the plow, leading to an increase in the pulling force, which in turn increases the slippage percentage. These results are consistent with (**Menkhi, 2012; Al-Shujairy, 2008).**

The increase in speed from 5 to 6.5 and then to 7.5 km/h led to an increase in the slippage percentage from 4.12 to 4.88 and then to 5.95%. However, all slippage percentages at all speeds were within the permissible limits for tracked tractors, which is 15%. This is consistent with **(Al-Ani, 2012)**, and the reason for the increase in the slippage percentage with increasing operational speed is that at lower speeds, there is greater adhesion between the contact area of the tractor tires and the soil surface. The adhesion decreases as the operational speed of the mechanical unit increases, due to the soil being well smoothed before the seeding process, resulting in the soil being finely fragmented, making it difficult for the tractor tires to maintain cohesion with it. This is in line with (**Hachim & Jebur, 2022; Al-Suhaibani & Ghaly, 2010; Al-Azzawi & Zeinaldeen, 2023; Jassim,2019).**

The result indicate non-significant interaction between plowing depth and forward speed, it is also evident from Table 3 that the highest slippage rate was recorded at the third depth (6 cm) with the third speed (7.5 km/h), with a value of 7.06%. The lowest slippage rate was recorded when working at the first depth (2 cm) with the first speed (5 km/h), with a value of 3.55%

Table (2): Effect of depth and forward speed on slippage percentage.

Depth cm	Forward speed km h⁻¹			Mean depth
	(٥)V1	(٦,٥)V2	(٧,٥)V3	
2 cm(D1)	3.55	3.83	4.92	4.10
4 cm(D2)	4.15	4.23	5.88	4.75
6 cm (D3)	4.57	6.67	7.06	6.10
LSD	N.S			٠,٣٢
Mean speed	4.12	4.88	5.95	
LSD	٠,٨٢			

Fuel consumption (liter ha^{-1})

Table (3) shows the effect of both each of the depth and forward speed of the tractor on the fuel consumption. When increasing the working depth from 2 to 4 and then to 6 cm led to an increase in fuel consumption from 7.04 to 7.69 and then to 7.96 L ha^{-1}. respectively The reason for this increase is attributed to the increased disturbed soil volume and the need for greater energy to perform the work. These results are consistent with (**Alwash et al., 2022; Abtan, 2000).**

It is evident from the results that increasing the speed from 5 to 6.5 and then to 7.5 km h^{-1} resulted in a decrease in fuel consumption from 8.89 to 6.85 and then to 6.94 L ha^{-1} Respectively. The decrease in fuel consumption is due to the fact that increasing speed leads to a decrease in energy consumed and the time required completing the work. This is in line with (**Hamzah *et al.*, 2021; Alsharifi & Ameen, 2018; Mankhi & Jebur, 2022).**

The highest fuel consumption rate was recorded at the interaction of a depth of 6 cm and the first forward speed of 5 km h^{-1}, with a value of 10.00 L ha^{-1}. The lowest fuel consumption rate was recorded when working at a depth of 2 cm and the third forward speed of 7.5 km/h, with a value of 6.39 L ha^{-1}.

Table (3): Effect of depth and forward speed on fuel consumption (liter ha^{-1}).

Depth cm	Forward speed km h⁻¹			Mean depth
	(٥)V1	(٦,٥)V2	(٧,٥)V3	
2 cm(D1)	7.78	6.94	6.39	7.04
4 cm(D2)	8.89	6.95	7.22	7.69
6 cm (D3)	10.00	6.67	7.22	7.96
LSD	0.57			0.54
Mean speed	8.89	6.85	6.94	
LSD	٠,٢٧			

Pulling Force (KN)

Table (4) shows the effect of both each of the depth and forward speed of the tractor on the pulling force. It is evident from that when increasing the working depth from 2 to 4 and then to 6 cm resulted in an increase in the pulling force from 9.11 to 10.22 and then to 11.33.

The reason for this increase is attributed to the fact that increasing the plowing depth increases the load on the plow, leading to an increase in the pulling force. These results are consistent with (**Taha &Taha, 2019; Naderloo *et al*., 2009).**

Furthermore, it is evident that increasing the speed from 5 to 6.5 and then to 7.5 km/h led to an increase in the pulling force from 9.78 to 10.00 and then to 10.89 kN. The reason for this increase is that higher speed leads to increased acceleration force of soil particles, increased vertical force on the plow shares, increased frictional resistance, and increased kinetic energy of the soil, resulting in an increase in the pulling force. This is supported by (**Alsharifi *et al*., 2019; Jebur & AL-Halfi 2022).**

The highest pulling force rate was recorded at the interaction of a depth of 6 cm and the third forward speed of 7.5 km h^{-1}, with a value of 12.00 kN. The lowest pulling force rate was recorded when working at a depth of 2 cm and the first forward speed of 5 km h^{-1}, with a value of 8.67 KN.

Table (4): Effect of depth and forward speed on pulling force (KN).

Depth cm	Forward speed km h^{-1}			Mean depth
	(٥)V1	(٦،٥)V2	(٧،٥)V3	
2 cm(D1)	8.67	9.00	9.67	9.11
4 cm(D2)	9.67	10.00	11.00	10.22
6 cm (D3)	11.00	11.00	12.00	11.33
LSD	N.S			0.54
Mean speed	9.78	10.00	10.89	
LSD	0.28			

The number of seeds per square meter:

Table (5) shows the effect of both each of the depth and forward speed of the tractor on the number of seeds. It is evident from that when increasing the working depth from 2 to 4 and then to 6 cm resulted in a statistically non-significant increase in the number of seeds from 4.78 to 5.11 and then to 5.22 plants m^{-2}. The reason for this increase is attributed to the increased depth occupied by the roots, allowing for a larger water distribution area and increased water and nutrient absorption. This provides more favorable conditions for the plants and enhances the efficiency of the photosynthetic process, resulting in higher growth and yield. This is in line with (**Jassim *et al*., 2018**).

Furthermore, it is evident from Table (4) that increasing the speed from 5 to 6.5 and then to 7.5 km h^{-1} led to a non-significant decrease in the number of seeds from 5.56 to 4.89 and then to 4.67 plants m^{-2}. The increase in speed disrupts the proper seed placement, causing the grains to fall at different depths, some of which may be too deep for surface emergence, making them susceptible to bird, rodent, and ant predation, or they may be buried too far from the surface, making it difficult for them to germinate. This is consistent with (**Al-Rajabu, 2002; Al-Khafaji & Al-Sabbagh, 2010; Rajabu & Qadu, 2018).**

Table (5): Effect of depth and forward speed on the number of seeds per square meter.

Depth cm	Forward speed km h-1			Mean depth
	(٥)V1	(٦،٥)V2	(٧،٥)V3	
2 cm(D1)	**5.33**	**4.67**	**4.33**	**4.78**
4 cm(D2)	**5.67**	**5.00**	**4.67**	**5.11**
6 cm (D3)	**5.67**	**5.00**	**5.00**	**5.22**
LSD	**N.S**			**N.S**
Mean speed	**9.78**	**10.00**	**10.89**	
LSD	**N.S**			

CONCLUSIONS

- The results showed that increasing the working depth from 2 to 4 and then to 6 cm led to an increase in slippage percentage, fuel consumption, and it also led to a significant decrease in both field productivity and field efficiency.
- The results also showed that an increase in practical speed led to an increase in both the slip percentage and field productivity, and it also led to a significant decrease in both field efficiency and fuel consumption.
- We recommend using the first depth of 2 cm and the third speed of 7.5 km * h^{-1} to record the best technical results for the mechanical unit, as it recorded the lowest fuel consumption rate and the overall best vegetative characteristics of the germination rate.

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