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EFFECT OF BLADE ANGLE TYPES AND FORWARD SPEED ON THE PERFORMANCE OF THE MURRAY-15.5HP LAWN MOWER

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ABSTRACT

A field experiment was conducted to design, implement, and test the effect of blade angle represented by cutting angle and foreword speed on the performance of a MURRAY-15.5hp lawn mower machine. Three types of blades with cutting angles of 20^o, 25^o, and a straight angle were used, as well as three forward speeds of 2.99, 4.32, and 5.60 km h-1. The slippage percentage, field productivity, material quantity and total costs were studied. The results indicated the following: decreasing the cutting angle from 25^o to 20^o and then to a straight angle considerably decreases the slippage percentage and a significant decrease in total costs .Also, a significant increase in the field and Material productivity. Increasing the foreword speed resulted in a significant increase in the slippage percentage and a significant increase in in the field and material productivity, and decrease in the total costs. The interaction between the straight blade type and the forward speed 2.99 km h^{-1} led to the lowest slippage at 8.34%, while the interaction between the straight blade type and forward speed 5.60 km h^{-1} resulted in the lowest total costs amounted to 12036 dinars*hectare^{-1} and the highest field productivity 0.360 ha h^{-1} while the highest material productivity was 121.25 kg h^{-1}.

Keywords: Blade, Total costs, Field productivity, Slippage percentage.

تأثير زاوية الشفرة والسرعة الأمامية على أداء جزازة العشب MURRAY-15.5hp

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الخلاصة

أجريت تجربة ميدانية لتصميم وتنفيذ واختبار تأثير نوع الشفرة المتمثلة بزاوية القطع وسرعة الامامية على أداء آلة جزازة العشب .MURRAY-15.5hp تم استخدام ثلاثة أنواع من الشفرات بزوايا قطع 20 درجة و 25 درجة وزاوية مستقيمة، بالإضافة إلى ثلاث سرعات أمامية 2.99 و 4.32 و 5.60 كيلومتر الساعة $^{-1}$. تم دراسة نسبة الانزلاق، والإنتاجية الحقلية، وانتاجية المادة والتكاليف الإجمالية. تشير النتائج إلى ما يلي: نقصان زاوية القطع من 25 درجة إلى 20 درجة ثم إلى زاوية مستقيمة يقلل بشكل كبير من نسبة الانزلاق وانخفاض كبير في إجمالي التكاليف، بالإضافة إلى زيادة معنوية في الإنتاجية الحقلية وانتاجية المادة. أدت زيادة السرعة ادت إلى زيادة كبيرة في نسبة الانزلاق وزيادة ملحوظة في الإنتاجية الحقية وانتاجية المادة، وانخفاض في إجمالي التكاليف. أدى التداخل بين نوع الشفرة المستقيمة والسرعة الأمامية 2.99 كم الساعة $^{-1}$ إلى أدنى انزلاق عند 8.34٪، بينما أدى التداخل بين نوع الشفرة المستقيمة والسرعة الأمامية 5.60 كم في الساعة إلى أدنى تكاليف إجمالية بلغت 12036 دينار هكتار $^{-1}$ وأعلى إنتاجية حقلية 0.360 هكتار ساعة$^{-1}$ وأعلى انتاجية مادة كانت 121.25 كغم ساعة $^{-1}$.

الكلمات المفتاحية: الشفرة، التكاليف الإجمالية، إنتاجية الحقل، جزازة العشب، نسبة الانزلاق.

* **Part of a master's thesis by the first researcher.**

INTRODUCTION

Green areas were known for the first time in England in the thirteenth century, and since that date they have become the main element in landscaping ،**(Salih, 2001)**. Green areas are defined as those areas that are covered with a group of closely spaced herbaceous plants, and when cut, their creeping branches grow profusely, covering the distance between the planted plants when their growth is integrated, to give an attractive shape like a green rug. **(Mahmood & Mohammed Amin, 1989)**. The establishment of parks has become a model for civilized cities **(Al-fatlawi & Jasim, 2019)**. Landscape design on the side of the roads is also very important to achieve the beautification of the road strategy, which aims to work jointly with architects and road engineers **(Hussain & Jasim, 2019).** One measure of the greatness of a city is its ability to provide entertainment and natural beauty **(Sharbazhery, *et al.*, 2019).** Especially after the population increase, which currently stands at 7.2 billion, is expected to reach about 9.2 billion by 2050 **(Tawfiq, 2019)**, and this requires an increase in the area of parks and recreational places. For this reason, it was necessary to think about producing machines and equipment that have specifications commensurate with the nature of the work to be done. Where the first lawn mower was invented by an English textile worker named Edwin Budding in 1827 in Thrupp, the Budding mower was designed mainly for cutting grass in sports fields and wide gardens **(bellis, 2010)**..Lawn mowers are machines used for leveling grass in lawns to maintain beauty and for recreational purposes. Rotary lawn mowers are two types of mowers used to cut grass. But research has shown that rotary lawn mowers are more efficient than reel mowers due to their clean cut and debris collection. Mowing, the most important part of a rotary mower is the cutting blade and the cutter deck housing which are factors that affect cutting quality **(Revi , *et al.*, 2016)**. Studies have shown that blades used for cutting forage should have a cutting angle in the range of 30-40° .The ideal cutting edge radius is about 0.05 mm and the rotary mower has shown minimum power requirements with blade angles between 25° and 30°. Studies have indicated the need for high impact speed, both in laboratory experiments on single shanks and in field trials on mowers **(O'Dogherty, 1982)**.
(Hamid, 2013)found that the highest speed of the lawn mower was 6.4 km per hour, achieved the highest practical cutting productivity of 0.6557 hectares* hour-1, the lowest fuel consumption was 1.62 liters * hectare-1, and the lowest efficiency was 83.97%, and that the full load of the engine recorded the highest practical productivity of 0.1080 hectares * At -1 the highest efficiency is 84.47%. When designing agricultural machinery, it is very necessary to take into consideration that it should be with the lowest expended capacity and the highest possible productivity in order to reduce the amount of fuel expended. No matter how small the difference in the amount of fuel consumed, it must be taken into account, especially when working in large areas **(Gebre, 1989)**.

MATERIAL AND METHOD

1- Materials:

The following materials were used in the field experiment:

- Riding Mower: A MURRAY-15.5hp American-made reel mower model 2010 was used, as shown in Figure (1).
- Cutting blades: The cutting blades were fabricated at different angles from the standard blade angles. The first blade, which is the standard blade available for the lawn mower, had a slanted cutting angle (25^o), referred to as (T1). The second blade had a slanted cutting angle (20^o), referred to as (T2). The third blade had a straight cutting angle and was

referred to as (T3). The blades of both types (T2, T3) were fabricated locally in a blacksmith workshop under the supervision of a specialized blacksmith with precise measurements. The blades were fabricated using the same steel used for the standard blade, as shown in Figure (2).

- Fuel Consumption Measurement Device

The fuel consumption measurement device consisted of a graduated plastic cylinder (1000 ml) equipped with a valve and set of rubber tubes, as shown in figure (3). This device was connected to a lawn mower and attached to the main fuel pump through tubes.

Figure (1): The MURRAY -15.5 mower which was used in the experiment**.**

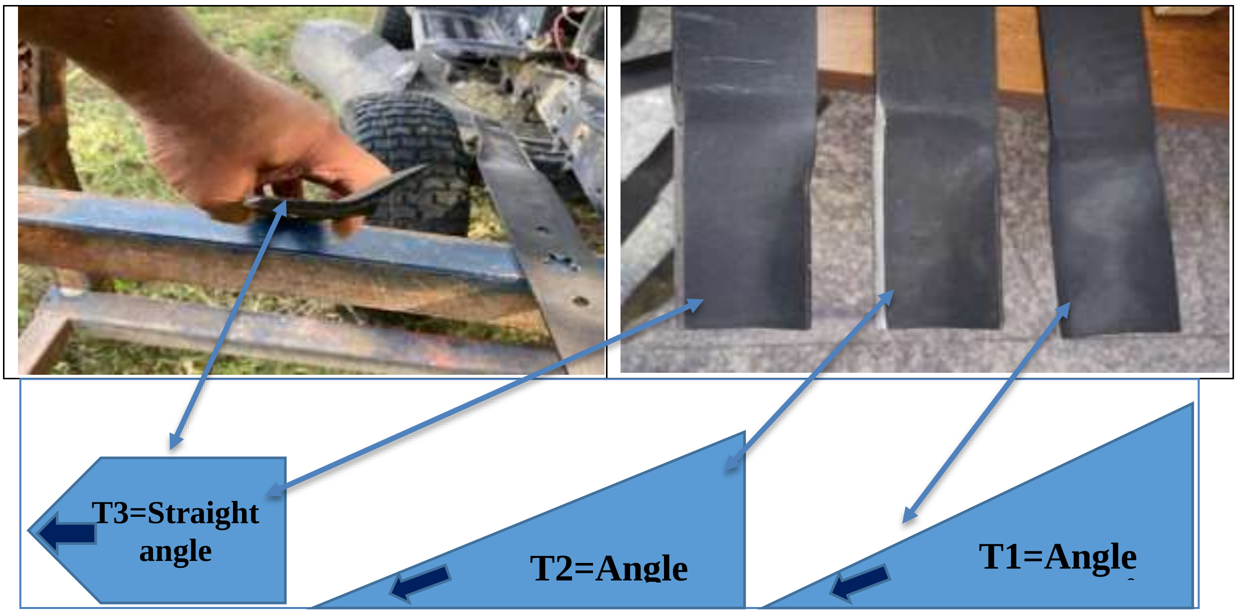

Figure (2): The shapes and angles of the blades which was used in the experiment.

Figure (3): Fuel consumption device.

Table (1): Specifications of the lawn mower used**.**

Type, Made, Year	Murray, USA, 2010
Serial no.	072610 C001224
Cylinder no.	1
Cooling system	Air
Engine power H. P	15.5
Starting system	Key switch - super glow
Fuel tank (L)	Gasoline 5
Type suspension seat	Mechanical spring
Speeds no.	6 forward and 1 rear
Cutting width (inch)	42
Tires front size	15. 6.00-6 NHS
Tires front and rear pressure (psi)	20
Tires rear size	20. 8.00-8NHS

2- Work Methods:

- **Experimental Field:**

The experiment was conducted using a Split-Plot arrangement according to the Randomized Complete Block Design (RCBD). Three replicates were used. The three blade types were allocated to the main plot, and foreword speeds were allocated to the sub-plots. The averages of the treatments were compared using the Least Significant Difference (LSD) test at a probability of 0.05.

This study was conducted at Al-Bustan Park, one of the gardens of the Umm Al-Qura Mosque site, affiliated with the Sunni Endowment Diwan in Al-Ghazaliyah district, Baghdad governorate, for the summer season of 2022 in the tenth month of the green lawn, which is composed of American Bermuda grass (*Cynodon dactylon*), with a 4500 square meter space. A 3200 square meter plot of ground that was 80 meters long and 40 meters wide was used as an experimental field. The experimental field was divided into blocks of (3x20) meters.

- **Experimental Design:**

Two factors were used: the first factor represented a main plot with blades of three angles:

a) The standard blade was tilted at an angle of (25^o) represented as (T1).

b) The standard blade was tilted at an angle of (20^o), locally adjusted, and represented as (T2).
c) Manufactured blade with a straight angle represented as (T3).

The second factor was the forward speed of the lawn mower machine, as a secondary factor with three selected levels of the gear speed number of the lawn mower machine, measured after fixing the engine rotation speed at the highest rotational speed (3160) revolutions per minute:

a) The first speed with number (3), which was (2.99) km h^{-1}, represented as (S1).
b) The fourth speed, which was (4.32) km h^{-1}, represented as (S2).
c) The fifth speed, which was (5.60) km h^{-1}, represented as (S3).

The experiment included nine treatments, which were 3x3 with three replicates, resulting in 27 experimental units. The length of each unit was 80m, and with three replicates, the length of each replicate was 20 m. The experimental unit's area was 60 m2, including leaving a 5m space at the beginning and end of each replication to acquire the specified speed for the lawn mower during work, as shown in the general experimental design. Data were analyzed using the (SAS) 2010 program **(Elsahooki & Waheeb, 1990)**

- **Experiment Execution Method:**

a) The fuel consumption device was installed and connected to the fuel system, and the engine's rotation speed was set to 3160 RPM by the manual fuel regulator located on the left of the steering regulator and the tachometer device.
b) The theoretical time was then measured for each speed for the selected numbers (3,4,5) fixed on the driver's seat's straight by the speed change regulator for the gearbox in sequence, ranging from (1-6), inside the experimental field on the grass.
c) The practical time for each treatment was then measured after starting the cutting blade, as well as the total time using the same previous method to measure the theoretical time and the amount of consumed fuel.
d) Collected the clipped grass for each transaction using the mowing waste collection box of the lawn mower, and then put it in nylon bags, and with the help of my colleagues, we put on each bag the name of the transaction, and then weight it.

3-Theoretical Calculations for the Studied Properties:

- **Percentage:** The percentage slip ratio was calculated using the following equations: **(Al-Binaa, 1990)**

$S = \frac{Vt - VP}{VT} \times 100$ ………………. (1)

Where: S: Slippage Percentage
VT: Theoretical Speed (km h^{-1})
VP: Actual Speed (km h^{-1})
The theoretical speed of the mower (VT):

$VT = \frac{St}{Tt} \times 3.6$……….km hr^{-1}…………. (2)

Where: St: Distance (m)
Tt: Theoretical Time
The actual speed of the mower (VP):

$VP = \frac{Sp}{Tp} \times 3.6$……….km hr^{-1}………… (3)

Where: Sp: Distance (m)
Tp: Actual Time (s)

- **Field Productivity:** Field productivity has been calculated in both its actual and theoretical parts using the following equations: and **(AL-Badri & AL-hadithy, 2011)**

EFC=Sp× Wp × T.U.C. ×0.1…………… (4)
TFC=Sp× Wp ×0.1……………. (5)
Where:
EFC: actual productivity of the machine (hectare hour^{-1})
Sp: actual field speed (km h^{-1})
Wp: actual working width of the machine (m)
T.U.C.: Time Exploitation Coefficient (calculated from the equation: Practical time / Total time) (Kepner, *et al.*, 1978)

- **Material Productivity:** The material productivity, which is a measure of agricultural materials and products such as fodder crops that are harvested, was calculated using the following equation: **(Al-Tahan, *et al.*, 1991)**

EMC = Yield/unit area (kg m^{-2}) ×10000……………. (6)
Where: EMC: material yield (kg hectare^{-1})
Yield/unit area: weight/unit area (kg m^{-2})

- **Total Costs**: It is the sum of fixed costs, variable costs and administrative costs and Is calculated through the following treatment: **(Laibi, 2022)**

$T._C = F.C + V.C + M_{a.c}$............ **(7)**
F.C. = Dep. + Int. + T.I.S. ………… **(8)**
F.C.**:** They are defined as those costs that do not change whether the machine works or not **:**
$Dep. = V_n - V_{n+1}$ ………. (**9**)
$V_n = P\left(1 - \frac{X}{L}\right)^n$……… (10)
$V_{n+1} = P\left(1 - \frac{X}{L}\right)^{n+1}$………… (11)

$$Int. = \frac{\left[\frac{(P + Vn)}{2}\right]}{h} \times Int.\ Rate$$ …………. (1**2**)

$$T.I.S. = \frac{P}{h} \times (T.I.S.)\ Rate$$ …………… (1**3**)

Where:
Pep. : annual depreciation (JD year^{-1})
Vn: the residual value of the machine at (n) years
Vn+1: the residual value of the machine at (n+1) years
P: The purchase price of the machine (JD)
X: The rate of consumption compared to the equal consumption method, and its value ranges from (1, 2), and the value of 1 was adopted in this equation
L: machine life in years (years)
n: age of the machine when calculating extinction.
Int.: interest on investment
h: The number of annual operating hours for the machine, which is (1000) hours year^{-1}
Int. Rate: The interest rate, which is a percentage of (10%).
T.I.S.: Taxes, Insurance, and Shelter (JD/H)
(T.I.S.) Rate: The percentage of taxes, insurance, and shelter (4%)

$V.C = F_{uc} + O.c + M.R.C + L.C$ ………. (14)
$Fu.c = QF \times Fu.p$ ……………. (15)
$FQ = \frac{Q \times 10000}{TL \times Wp \times 1000}$ …………….. (16)
Where:
FQ: Fuel Consumption per Hectare (L $hectare^{-1}$)
Q: Fuel consumption during operation (mL)
TL: Length of operation (m)
Wp: Actual width of machine or tillage (m)
$O.c = \frac{Q.o \times O.p}{P.o \times EFC}$ ………….. (16)
O.c: Oil costs (JD $hectare^{-1}$)
Q.o: The amount of oil added in each oil change (liter and a half) for the machine used in the experiment
O.p: The price of a liter of oil is (5000 dinars * 1 liter) according to the official price of the state 2022
P.o: The duration of the oil change is (100 daily working hours) according to the procedures followed in the experimental work site
$M.R.C = \frac{P}{h * EFC} \times (M.R.C)$ Rate …………… (17)
M.R.C: Maintenance and Repair Costs (JD $hectare^{-1}$)
(M.R.C) Rate: The percentage of maintenance and repair, with values ranging between (2.2-7.4%) of the purchase price of the machine. The ratio (4.5%) will be used when calculating maintenance and repair costs.
$L.C = \frac{DL}{d} \times EFC$ ……….. (18)
L.C: labor costs (JD $hectare^{-1}$)
D.L: The worker's daily wage (dinar day^{-1}), amounting to 17,000 Iraqi dinars, according to the standard in the workplace.
d: The number of daily operating hours, which is 6 hours *day^{-1}, depending on the experimental site
$M_{a.c} = (F.C + V.C) \times 0.10$ ………… (19)
Ma.c: administrative costs for the machine

RESULTS

Slippage Percentage:

The results indicate a significant difference between the average cutting angles in Table (2),where the highest was 14.00 % and the lowest was 10.71 % for both treatment T3 and T1. because a larger blade angle leads to an increase in the required cutting force, which in turn increased the overall resistance of the mechanical unit leading to an increase in the percentage of slippage, also what is approved by the straight blade, which requires fewer cutting forces. There was a significant difference in the average speed, with T3, which had the highest speed of 5.60 km hr^{-1} and T1 which had the lowest speed of 2.99 km hr^{-1}. The reason for that maybe related to the slippage rate which was less than 15 % the allowed limits, Additionally, Table (2) shows an increase in slippage with increasing selected speed by the researcher for all types of blades used, which were (2.99, 4.33, and 5.60) km hr^{-1}. The least slippage rate was recorded when using the straight T3 blade and the lowest forward speed (S1) which was 8.34%. This is due to the low cutting force required for the blade, which reduces the total resistance of the cut, and thus reduces the slippage in the driving wheel. The highest slippage was recorded when using the standard T1 blade and the highest selected forward speed (S3), which was 14.90%. The reason behind that because forward speed and slippage have a positive relationship, which is with agreement with **(AL-Ahmad & Ibrahim, 2016; Jabr & Al-Sayah, 2017; Alwash, *et al.*, 2022; Hajem & Jebur, 2022; Al-Osh, *et al.*, 2022)**

Table (2): The effect of blade type represented by the cutting angle and ground speed on the percentage of slippage.

Cutting angle	Selected speed			Mean cutting angle
	S1	S2	S3	
T1	12.49	14.61	14.90	**14.00[a]**
T2	11.30	12.86	13.25	**12.47[b]**
T3	8.34	10.83	12.95	**10.71[c]**
LSD*	1.05			**0.87**
Mean	10.71[c]	12.77[b]	13.70[a]	
LSD	0.58			

***LSD (Least Significant Difference) is the value at a particular level of statistical probability (e.g., P≤0.05-means with 95% accuracy).**

Field Productivity:

The results indicate a significant difference between the average cutting angles in Table (3), where the highest was 0.320[a] ha hour $^{-1}$ and the lowest was 0.300[b] ha hour $^{-1}$ for both treatment T3 and T1. Because of the type of straight knife used, which does not require high cutting force, which leads to an increase in practical speed, and then an increase in the productivity of the mower. This is consistent with **(AL-Ahmad & Ibrahim, 2016; Ahmed & Dosoky, 2009)**. Also, results show that there is a significant difference between the different speeds (S1, S2, and S3) and the reason is attributed to the fact that there is a direct relationship between the practical speed of the mechanical unit and the field productivity. It was found that when the mower operates at a forward speed of (2.99, 4.33, 5.60) km hr^{-1} respectively, there was a noticeable increase in the field productivity averages for the three speeds (0.260[c], 0.310[b], 0.350[a]) ha hour $^{-1}$ respectively. Table (3) shows an increase in field productivity values as the selected speed increases for all types of blades used. The highest field productivity value was recorded when the straight blade (T3) was used with the highest forward speed (S3), which was (0.360) ha hour $^{-1}$. The reason for this is the less force required for cutting, which leads to a reduction in the overall resistance to mowing, thus reducing the slipping that occurs in the driving wheel and increasing the practical speed. The lowest field productivity value was recorded when the standard blade (T1) was used with the lowest forward speed (S1), which was (0.250) ha hour $^{-1}$. This is attributed to the direct relationship between the forward speed and the field productivity, which is consistent **with (Al-Hadithy & Al-Badri, 2012; Atallah , M. M., 2013; Hamid, 2013; Omar, *et al.*, 2021; Jassim, 2019; Taha & Taha, 2019; Mohammed & Jassim, 2021; Laibi & Al-Ani, 2022)**.

Table (3): The effect of blade type represented by the cutting angle and ground speed on the field productivity.

Cutting angle	Selected speed			Mean cutting angle
	S1	S2	S3	
T1	0.250	0.300	0.350	0.300[b]
T2	0.250	0.310	0.350	0.305[b]
T3	0.280	0.320	0.360	0.320[a]
LSD*	0.016			0.014
Mean	0.260[c]	0.310[b]	0.350[a]	
LSD	**0.009**			

***LSD (Least Significant Difference) is the value at a particular level of statistical probability (e.g., P≤0.05-means with 95% accuracy).**

Article Productivity:

The results indicate a significant difference between the average cutting angles in Table (4), where the highest was 102.01[a] Kg hour $^{-1}$ and the lowest was 93.24[b] Kg hour $^{-1}$ for both treatment T3 and T1. Because of the type of straight knife used, which does not require high cutting force, which leads to an increase in practical speed, and then an increase in the productivity of the mower. This is consistent with **(AL-Ahmad & Ibrahim, 2016; Ahmed & Dosoky, 2009)**. Also, results show that there is a significant difference between the different speeds (S1, S2, S3) and the reason is attributed to the fact that there is a direct relationship between the practical speed of the mechanical unit and the field productivity. It was found that when the mower operates at a forward speed of (2.99, 4.33, 5.60) km hr $^{-1}$, there was a noticeable increase in the field productivity averages for the three speeds (76.62c, 100.71b, 118.10a) Kg hour $^{-1}$ respectively. Table (4) shows an increase in field productivity values as the selected speed increases for all types of blades used. The highest field productivity value was recorded when the straight blade (T3) was used with the highest forward speed (S3), which was (121.25) Kg hour $^{-1}$ The reason for this is the less force required for cutting, which leads to a reduction in the overall resistance to mowing and then increase the speed and thus increase the productivity of the material. The lowest field productivity value was recorded when the standard blade (T1) was used with the lowest forward speed (S1), which was (0.250) Kg hour $^{-1}$. The reason is attributed to the increase in the force required to cut the knife, which leads to an increase in the total resistance of the mower, and then a decrease in speed, and thus a decrease in the amount of material, and this is consistent with **(Al-Ani, 2001; Al-Khaldi, 2006; AL-sammarraie & Özbek, 2019)**

Table (4): The effect of blade type represented by the cutting angle and ground speed on the article productivity

Cutting angle	Selected speed			Mean cutting angle
	S1	S2	S3	
T1	75.69	89.72	114.30	93.24[b]
T2	76.67	105.14	118.75	100.19[a]
T3	77.50	107.28	121.25	102.01[a]
LSD*	8.48			0.014
Mean	76.62[c]	100.71[b]	118.10[a]	
LSD	5.78			

***LSD (Least Significant Difference) is the value at a particular level of statistical probability (e.g., P≤0.05-means with 95% accuracy).**

Total Costs:

The results show a significant difference between the means for the cutting angles (Table 3), where the highest value was recorded for the straight blade (15393[a]) D hectare^{-1} and the lowest value was for the standard blade (14555[b])D hectare^{-1} for both (T1, T3) respectively. The reason is due to the inverse relationship between productivity and the total costs of the mower, where the increase in speed due to the lack of cutting effort led to an increase in productivity. This in turn leads to a decrease in costs. This was achieved in the type of straight knife used, and this is consistent with **(Ahmed & Dosoky, 2009)**. Also, results show that there is a significant difference between the different speeds (S1, S2, S3) and the reason is attributed to the fact that there is an inverse relationship between the practical speed of the mechanical unit and the total costs. It was found that when the mower operates at a forward speed of (2.99, 4.33, and 5.60) km hr^{-1}, there was a noticeable decrease in the total costs averages for the three speeds (18241[a], 14353[b], 12357[c]) D hectare^{-1}**.** Table (3) shows a decrease in total costs values as the selected speed increases for all types of blades used. The highest total costs value was recorded when the standard blade (T1) was used with the lowest forward speed (S1), which was (18745) D hectare^{-1}.The lowest field efficiency value was recorded when the straight blade (T3) was used with the highest forward speed (S3), which was (121.25) D hectare^{-1}. This is attributed to the inverse relationship between the forward speed and the field efficiency, which is consistent with**, (El-Sharabasy, 2013; Al-Azzawi & Zeinaldeen, 2023)**.

Table (5): The effect of blade type represented by the cutting angle and ground speed on the total costs.

Cutting angle	Selected speed			Mean cutting angle
	S1	S2	S3	
T1	18745	14790	12644	15393[a]
T2	18302	14319	12391	15004[ab]
T3	17677	13952	121.25	14555[b]
LSD*	824			557
Mean	18241[a]	14353[b]	12357[c]	
LSD	**513**			

***LSD (Least Significant Difference) is the value at a particular Level of statistical probability (e.g., P≤0.05-means with 95% accuracy).**

CONCLUSION

The decrease in the cutting angle of the blade type from 25^o to 20^o, then to the straight angle, result in a significant decrease in the average values of slippage and total costs, so an increase in the average values of field productivity which was article productivity. On the other hand, the increase in the forward speed of the grass cutting machine led to an increase in slippage values, field productivity and article productivity. However, the opposite total costs, where the increase in forward speed led to a noticeable decrease in these parameters.

The study illustrated that the blade type represented by the straight cutting angle T3, which was designed in the workshop, proved to be efficient in achieving the study's goal. It has had the best technical specifications to evaluate the performance of the Murray 2010 lawn mower and all types of mowers within the selected forward speed, engine rotation speed, and 15.5 horsepower capacity limits. It recorded the lowest slippage rate and total costs and the highest field productivity and article productivity, leading to a reduction in the economic costs for the user, especially when working in large green areas.

Recommendations:

Researchers recommend using the straight blade, especially in large areas, due to the significant differences it achieved in the studied technical properties. Researchers recommend conducting further studies using the straight blade in various types and shapes of lawn mowers machines. Also, recommend study the use of the straight blade with different cutting heights for the lawn mowers machine. Finally the combination of the straight blade (T3) with a speed of (5.60 km hr^{-1}) to achieve lower total costs and the highest field productivity and article productivity and using the combination of the straight blade (T3) with a speed of (2.99 km hr^{-1}) to achieve the lowest slippage ratio.

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