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Comparative Field Performance Evaluation of Two Seed Drills Under River Nile State Condition

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Abstract

The experiment was conducted in Atbara in one of the food security project (10 km north of Atbara) during 2018/ 19 to study the effects of seed drill type (Agro master BM22 and Titan3000) and three forward speeds (6, 7.5and 9 km/hr.) on machine performance parameters such as: wheel slippage, the fuel consumption (lit/hr.), the actual field capacity (fed /hr.) and field efficiency (%). The results showed that, wheel slippage, the fuel consumption (lit /hr.), the actual field capacity (ha /hr.) and field efficiency were better in the seed drill I (Agro master BM22) than in the seed drill II (Titan 3000). Seed drill I registered wheel slippage of 8.4%, fuel consumption 11.24 lit/ha,actual field capacity 1.16 ha/hr. and field efficiency 57.1 % .Seed drill II registered wheel slippage 9.6 % ,fuel consumption 13.5 lit/ha ,actual field capacity 0. 95 ha/hr. and field efficiency 45 %. As the forward speed increased from 6 km/hr. to 9 km/hr., the average fuel consumption (lit./hr.), the actual field capacity (ha /hr.) and field efficiency were increased by .6%. The wheel slippage was decreased by 10 % for both seed drills as speed was increased. Statistically, the differences between the effects of two seed drills and forward speeds on slippage and fuel consumption were found highly significant ($P<0.05$) under the two seed drill types.

Keywords: seeder, Fuel consumption, wheel slippage and effective field capacity

مقارنة تقييم الأداء الحقلي لزراعتي بذور تحت ظروف ولاية نهر النيل

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المستخلص

أجريت التجربة في عطبرة في أحد مشاريع الأمن الغذائي (10 كم شمال عطبرة) خلال عام 2019/2018 لدراسة تأثير نوع الة زرعة البذور من نوع (Agro master BM22 و Titan3000) وثلاث سرعات أمامية 6 ، 7.5 و 9 (كلم /ساعة)وفقًا لمعايير أداء الالة مثل: انزلاق العجلة ، واستهلاك الوقود (لتر / ساعة) ، والسعة الحقلية الفعلية (هكتار / بالساعة) والكفاءة الحقلية (٪). أظهرت النتائج أن انزلاق العجلة واستهلاك الوقود (لتر / ساعة) والسعة الحقلية الفعلية (هكتار / ساعة) وكفاءة الحقل كانت افضل في زرعة البذور (Agro Master BM22) مما كانت عليه في زرعة البذور II (Titan3000) تم تسجيل انزلاق العجلة بنسبة 8.4٪ ، واستهلاك الوقود 11.24 لتر / هكتار ، والقدرة الحقلية الفعلية 1.16 هكتار / ساعة ، وكفاءة الحقل 57.1٪ ، وزرعة البذور الثاني ، انزلاق العجلة بنسبة 9.6٪ ، واستهلاك الوقود 13.5 لتر / هكتار ، والقدرة الحقلية الفعلية 0.95 هكتار / ساعة والكفاءة الحقلية 45٪. مع زيادة السرعة الأمامية من 6 كم / ساعة إلى 9 كم / ساعة ، تمت زيادة متوسط استهلاك الوقود (لتر / ساعة) ، والقدرة الحقلية الفعلية (هكتار / ساعة) والكفاءة الحقلية بنسبة 0.6 ٪. تم تقليل انزلاق العجلة بنسبة 10٪ لكل من زراعات البذور مع زيادة السرعة. إحصائيا ، الفروق بين تأثير اثنين من الزراعات البذور والسرعات الأمامية على الانزلاق واستهلاك الوقود وجدت اختلافا معنويا (P <0.05) تحت نوعي زراعات البذور

Introduction

Farm machinery is an important element for agricultural development and crop production in many developed and developing countries. The use of machines for agricultural operations has been one of the outstanding developments in the global agriculture during the last decade (Kheiry, *et al.*, 2017).

The planting operation is one of the most important cultural practices associated with crop production. Increases in crop yield, cropping reliability, cropping frequency and crop returns all depend on the uniform and timely establishment of optimum plant populations (Murray *et al.*, 2006).

Proper application of mechanical power for planting will improve the quality of the operation; conserve amounts of seeds and save fuel, labour and time (Dahab, *et al.*, 2007, Tillett *et al.*, 2002 and James, 2005). Proper selection of planting machine that suits the available power, crop type and soil condition is important to reduce energy required Hunt (1995).

Planting depth is a major determinant of seedling emergence and hence one of the most important operational requirements of a planting machine (Rainbow *et al.*, 1992). Inadequate depth control accuracy is recognized by farmers (McGahan, 1992) and researchers as a major deficiency of current broad acre planting machines. Providing planting machines capable of maintaining uniform depth under field conditions is a major challenge for equipment designers (Riethmuller , 1990 ; Janke, 1985), particularly under direct drilling conditions because of the greater surface roughness and variability of soil structure and residue levels.

The main objective of the present study is to evaluate the machine performance of two seed drill machines (seed drill I - Agro master BM22) and seed drill II (Titan 3000) as affected by three forward speeds (6, 7.5 and 9 km/hr.).

Materials and Methods

A field experiment was carried out in one of the food security project farms (Atbara) to investigate the effects of see drill machine type on machine performance. The soil is classified as Silt Clay. Some soil properties of the experimental area are shown in Table 1. The machinery used in the experiment was the following:

1- Two Massey Ferguson tractors, one (60 kW) for testing and the other (67.5 kW) as auxiliary for pulling and draft measurements.

2- Two seed drill machines (agro master – (seed drill I) and Titan – (seed drill II) are used. Technical specification of seed drill Agro master shown in Table 2 and plate 1 and technical specifications of seed drill Titan are shown in Table 3 and plate 2. Both are tractor mounted and of four units. Other equipment's used were, a hydraulic dynamometer for draft measurement, Graduated tube and fuel container for measuring the tractor fuel consumption.

A split-plot design with three replicates for evaluation of seed drill machines was used. The Two seed drill machines were assigned to the main plots and the three forward speeds to the subplot. The area was 1.03 fed (132 m x 32.8 m) divided into two main plots (seed drill machines) and each main plot was divided into three subplots (speeds). The area of the subplot was 192 m2 (40 m x 4.3 m) and were separated by a distance of 1 m while the main plots separated by 3m distance. Table 1 shows some soil properties of the experimental area, wheel slippage, the fuel consumption (lit./hr.),

Measurement

Measurement of Operational speed:

A distance of 280 meters under the experimental area was pre-determined. Flags marked ends. The time required for the machine to cover this distance at the recommended operating speed was recorded. The treatment was repeated four times. The machine speed was estimated by determining the mean for the times taken. The machine speed was obtained using the following equation:

$$\boldsymbol{Speed\ \left(\frac{km}{hr}\right) = \frac{280\ (m)}{time\ in\ secentes\ to\ cover\ 280\ (m)}\quad x\quad \frac{3600sec}{1000m}} \ldots \mathbf{1}$$

Measurement of wheel slippage

The measurement of wheel slippage was done for drive wheel of planters. At first, the distance traveled by planter for 10 revolutions of the drive wheel was recorded without load. Then, after three observations were taken for the same number of revolutions when operated with load, the average of these observations was calculated. The percentage wheel slippage of two planters was then calculated as follow following equation:

$$\boldsymbol{Slippage}\% = \mathbf{1} - \frac{\boldsymbol{actual\ distance\ traveled\ (without\ loaded)(m)}}{\boldsymbol{theoretical\ distance\ traveled\ (with\ load)\ (m}} \ldots 2$$

Fuel consumption measurement

The fuel tank of MF-290 tractor was filled up to its top level before field-testing. After planting, the tractor engine was stopped and the fuel tank was refilled up to the same level with the graduated cylinder to determine the quantity of diesel fuel needed to refill the tractor tank up to the same level. Fuel consumption per hectare in each plot was calculated by the following formula:

Fuel consumption in each plot was measure by the method described by James (2005) and calculated as follows:

$$\boldsymbol{The\ fuel\ consumption\ rate\ \left(\frac{l}{fed}\right) = \frac{\left(Reading\ cylinder\,\frac{ml}{1000}\right)}{Area\ of\ plot\,\frac{m2}{4200}}\ \ldots\ 3}$$

$$\boldsymbol{The\ fuel\ consumption\ rate\ \left(\frac{l}{hr}\right) = \frac{\left(Reading\ cylinder\,\frac{ml}{1000}\right)}{time\ requried\ to\ cover\ plot\ (hr)}\ldots 4}$$

Measurement of field capacity

Field capacity includes the following; a(Actual field capacity is defined as the actual rate of coverage by the machine based upon the total field time, expressed as fed/hr. Actual Field capacity in fed/hr. was calculated as follow:

$$\boldsymbol{Actual\ Field\ capacity\ = \frac{Area\ covered\ (fed)}{Time\ taken\ (hr)}\ldots 5}$$

b) Theoretical field capacity: Theoretical Field capacity in Fed/hr. was calculated as follows: Theoretical Field capacity =

$$\boldsymbol{Theoretical\ Field\ capacity = \frac{working\ width\ (m) * Speed\ (km/hr)\ *\ 1000\ (m)}{4200\ (m2)}}\ \ldots 6$$

Measurement of field efficiency

Field efficiency is defined as the rate of actual field capacity to the theoretical field capacity expressed as percentage. Field efficiency was calculated as follows:

$$\text{Field efficiency} = \frac{\text{Actual Field Capacity}}{\text{Theoretical Field Capacity}}\ x\ 100 \ldots 7$$

Statistical analyses

The data collected was statistically analyzed using PROC GLM (General Liner Model) procedure of SAS institute (SAS, 2002-03). The least significant difference LSD (á = 0.05) approach was used to compare the mean values of results for comparison of different treatments

Results and Discussion

Generally, the results showed that, wheel slippage and the fuel consumption (lit /hr.) in two different types of seed drill machines were greater in the seed drill II than in the seed drill I. the average values of wheel slippage for the seed drill I (agro master) was 8.4% while in Seed drill II (Titan) it was 9.6 % comparisons are made from Figure1 between both machines , it is clear that, the wheel slippage for the seed drill II is found to be greater by 1.1% than Seed drill I . The average values of fuel consumption for the seed drill I (agro master) was 11.24 lit/ha while in Seed drill II (Titan) it was 13.58 lit/ha comparisons are made from Figure1 between both machines , it is clear that, the fuel consumption for the seed drill II is found to be greater by 1.1% than Seed drill I this may be attributed to that the greater wheel slippage increase the machine draft, and with an increase in soil draft leads to increase the fuel consumption. This result agrees with the findings of (Malik *et al.*, 2017) who found that, any increase in machine draft lead to increase in the fuel consumption.

differences in field capacity for the two type of seed drill machine were, statistically, highly significant (P<0.05) .From the results shown in table 4 found that the average actual field capacity (ha/hr.) obtained from the tested implement at two seed drill machine types, was (1.16 ha/hr.) for the seed drill I and (0. 95 ha /hr) for seed drill II. Generally, it is clear that seed drill I recorded better results in actual field capacity by (1.2%) compared to seed drill II.

The average values for field efficiency at different type of seed drill machines The statistical analysis showed highly significant difference in the two types of seed drill machine (P<0.05) (Table 4). As shown in figure (1), the average value of field efficiency obtained from the field for both machine was 57% and 45% for Seed drill I and Seed drill II respectively. The average increasing percentage for field efficiency at seed drill I (1) was (1.24%) compared with seed drill II.

As shown in (Table 5) .The effects of the Seed drill types and differences in forward speeds on slippage, fuel consumption, and effective field capacity, the average slippage as percentage was observed to be was higher for seed drill II than seed drill 1

8.4% in the seed drill I and by 9.6 % in the seed drill II . This may be due to the higher draft forces exerted by the weight of the machine. This agrees with Albana and Hassan (1990). As the forward speed increased, the slippage decreased.

The result showed that the average fuel consumption in the seed drill II was generally higher compared to the seed drill I. As the forward speed was increased from 6 km/h to 9 km/h, the fuel consumption was increased (10.8- 11.8L/hr. for the seed drill I and (11.9- 13.0 L/hr.) for the seed drill II. This agrees with Malik *et al* (2017). As the fuel consumption increased linearly with increase in forward speed.

For both seed drills, the average effective field capacity increased as the forward speed increased.(50.1-62.7%)for the seed drill I and (31.9-45.5%) for the seed drill II increased it as the speed was increased from 6 km/h to 9 km/h (Table5). for the effective field capacity showed highly significant differences between effect of the two seed drill types at 5% level, while the differences between the effect of the three forward speeds was significant at 5% level.

For both seed drills, the average effective field capacity increased as the forward speed increased. The statistical analysis showed highly significant difference in the two types of seed drill machine ($P<0.05$) (Table 5). The average value of field capacity obtained from the field for both machine was 1.1-1.2 ha/hr and 0.7-0.9 ha/hr for Seed drill I and Seed drill II respectively**.**

Conclusion

The wheel slippage and fuel consumption and wheel slippage were better in the seed drill I than in the seed drill II also effective field capacity. The differences between the effects of two seed drill machines were found highly significantly at level 5% .also the differences between the effects of two Seed drill and forward speeds on slippage and fuel consumption were found highly significantly at level 5% under the two River Nile state conditions.

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Table (1) some soil properties of the experimental area in one of the food security project farms (Atbara)

Table (1): Soil analysis of experimental site

Depth	**pH**	**Na**	**Mg**	**Particle size distribution**			**Textural Class**
				Sand	Silt	Clay	**Silt Clay**
0-15	6.7	0.13	3.03	0.14	0.67	1.003	
15-30	6.79	0.13	3.13	0.16	1.03	1.0044	

Table (2): Technical specification (seed drill Agro master)

Technical specification	**Unit**	**BM22**
Number of dis	Pcs	22
Total width (w)	Mm	3890
Total length (L)	Mm	2940
Total height (H)	Mm	1430
Working width (L1)	Cm	3124
Length of hopper (L2)	Mm	3290
Space between wheels	Mm	4006
Fertilize hopper volume	dm3	350
Seed hopper volume	dm3	503
Fertilize hopper capacity	Kg	310
Required power	Hp	85-90
Total weight	Kg	1120

Table (3) Technical specification (seed drill Titan)

Titan 3000	Type
Working width (m)	3(m)
Hopper capacity (l)	
- Total (= available in organic)	4070
-Seed, min	1720
- Seed, max	2900
- Fertilizer, max	2350
Basic machine weight (kg)	
- Empty	
- With full hoppers	3050
- Wheat and fertilizer	6900
Basic machine dimensions (cm)	
-Height to the edge of the hopper	208
- Width	300
- Length without the drawbar	307

Plate (1) seed drill I (Agro master)

Plate (2) seed drill II (Titan-3000)