

Effect of Different Seed Drill Covering Devices on Forage Sorghum Seed Emergence and Machine Performance

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Abstract – An experiment was conducted in the farm of College of Agricultural Studies - Sudan University of Science and Technology-Sudan, to study the effect of different types of covering devices on the performance of grain seed drill and seed emergence. The type of soil at the farm is considered as a light clay soil. The experiment was carried out with a mounted Seed drill with four units assembled locally by GIAD factory – Sudan in order to study the effect of four seed covering devices (notched double disk followed by two small scrapers (CD1), notched double disk (CD2), two small scrapers followed by rubber wheel (CD3) and small scrapers type (CD4) on planter slippage, field capacity, fuel consumption, and seed emergence percentage.

The results showed that, the differences in field capacity, wheel slippage and seedling emergence between different covering devices were statistically significant ($P < 0.05$), while the fuel consumption showed a significant difference between the treatments.

Keywords – Seed Drill, Covering Device, Wheel Slippage, Effective Field Capacity, Seed Emergence.

I. 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 [1].

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 [2].

Proper application of mechanical power for planting will improve the quality of the operation; conserve amounts of seeds and save fuel, labour and time [3]; [4] and [5]. Proper selection of planting machine that suit the available power, crop type and soil condition is important to reduce energy required [6].

Planting depth is a major determinant of seedling emergence and hence one of the most important operational requirements of a planting machine [7]. Inadequate depth control accuracy is recognized by farmers [8] and researchers [9] as a major deficiency of current broadacre planting machines. Providing planting machines capable of maintaining uniform depth under

field conditions is a major challenge for equipment designers [10]; [11]), particularly under direct drilling conditions because of the greater surface roughness and variability of soil structure and residue levels [12]; [13]).

Seeding depth is influenced by the physical placement of seeds within the furrow and the amount of soil cover. Both the vertical seed spread and the uniformity of soil cover will influence the final variation in seeding depth. While seed boot design and setting and matching to point type dictates the quality of seed placement 'This is only half of the equation. Seed covering is another significant factor [14].

Press wheels can also be used to modify the depth of cover in addition to firming the seedbed, particularly where full-width cultivation for weed control is performed at time of planting. Under these conditions, the press wheels substantially reduce the depth of cover and give a higher degree of uniformity in the depth of cover [7], and [15]).

The depression over the seeded row as a result of press wheel action can have an additional advantage. Where there is low-intensity, short-duration rainfall after planting, the surface profile tends to concentrate runoff in the depression immediately above the seeded row and improve the moisture status around the emerging seedling [15]). Where more significant rainfall events occur, the concentration of moisture above the seeded row may kill seedlings as a result of waterlogged conditions. Further, if soil is moved into the depression as a consequence of side-wall slumping or erosion, the resulting depth of cover may restrict emergence [7]).

Seed covering devices are specifically designed to promote soil flow back into the furrow to cover the seed after placement and/or firming. They play an important role in promoting and stabilizing conditions conducive to rapid seed germination and influencing seed emergence and establishment through the manipulation of the depth of soil cover over the seed. [2].

Planting operation in most agriculture schemes of Sudan was carried out manually which lead to the delay of the subsequent operations and affected the final yield of most crops. Recently, there are many types of planting machines introduced to be used in the agriculture of Sudan without selection of suitable ones for local conditions.

Recently, most of farm machines are imported and these are not specially designed to operate in the various Sudan regions and states. Most of farm machines are imported and there are not specially designed to operate in the various specific tropical conditions. In general, they are imported without any standardized testing and evaluation. In addition, it is realized that many of locally manufactured agricultural implements in Sudan are substandard quality. The low quality machinery leads to financial losses and at times is also unsafe for operation in the field.

The main objectives of the present study, is to study the effect of different seed drill covering devices on machine

performance such as slippage, field capacity, fuel consumption, seed emergence and planting depth.

II. MATERIALS AND METHODS

A. Experimental site

The experiment was conducted at the farm of collage Sudan University of Science and Technology - Khartoum North-Sudan. The experiment was conducted during February 2016. Soil samples were collected at the depth of 0-40 cm to determine soil texture. Soil texture was found to be light clay soil. The soil physical properties of the experimental site are shown in Table 1. The experimental site prior to this study had been under disk plough in monoculture with animal fodder crops for a long time.

Table 1. Some soil physical properties of the experimental site

Depth/cm	Bulk density gm/cm ³	Moisture content %	Particle size distribution			Textural class
			Clay	Silt	Sandy	
0 -20	1.57	11.52	31	57.1	11.9	Silt clay
20 - 40	1.54	15.2	57.1	21.4	21.4	Clay

Source: Osman et al, 2011

B. Experimental Design and Treatment Applications

An experimental plot consalmaisting of four treatments and three replicates was laid out in randomized complete block design (RCBD). The treatments consisted of four levels of seed covering device as shown in (Fig. 1)

All seeder is equipped with the Full runner type furrow opener.(Fig. 1) (1st covering device was notched wheel followed by two small scrapers (C.D1), the 2nd was notched wheel (C.D2), the 3rd one was rubber wheel followed by two small scrapers (C.D3) and the 4th one is small scappers type (C.D4). The size of the plots was 60 m×15 m. The plots were separated by 1 m wide buffer strips and there was 3 m gap between 2 plots for the tractor. Average operating speed recorded for each treatments was 8.5 km/h, this working speeds was commonly used by farmers and represent actual working conditions and it was achieved by adjusted the engine speed of the tractor at 1500 r/min by using a hand accelerator lever to maintain steady engine r/min on the dashboard, during field operation tractor was operated with the implement raised up for 100 m and the time was recorded by stopwatch this method followed 10 times and finally the tractor average forward speed was found 8.5 km/h. Actual travel speed of the tractor for each treatments were measured by the same procedure mentioned above with the implements dropped on ground and the tractor traveled the same distance (100 m). Depth for each treatment was measured after completing the planting as the vertical distance from the top of the undisturbed soil surface to the small ridge caused by the covering devices. The implement used in the experiment is a mounted Seed drill with four units assembled locally by GIAD, (ATESPAR) – Sudan. In this study Forage sorghum (Sorghum bicolor var. Dura) seeds of 97% purity and germination percentages of 92%, were used. [16].

C. Measurements:

- Effective field Capacity (EFC)

The time lost in the field such as turning, adjustment and change of gear was recorded and time used for real work also recorded. The field capacity was calculated by using the equation given by [17].

$$EFC = \frac{A}{T_p + T_t}$$

EFC = Effective field capacity (ha/h); A = Area tilled, ha; T_p = productive time, h; T_t = non- productive time, h.

- Travel Reduction (%)

The travel reduction (Slippage) of the tested machine was determined by marked the rear wheel at a portion tangent to the ground surface, then distance travel in 10 revolutions with load and without load were marked and measured. The travel reduction was calculated using the formula:

$$\text{Travel Reduction (Slippage\%)} = \frac{(L_1 - L_2)}{L_1} \times 100$$

Where: L1 = actual distance with no load (m).
L2 =actual distance with load (m).

- Fuel Consumption:

For measuring the fuel consumption of tractor, the fuel tank was filled up to neck of the fuel tank before and after the planting operation in each plot. The amount of refilling measured after the test was the fuel consumption for planting operation in each plot and it was expressed as liter per hour and calculated as follows:

$$FC \text{ rate (L / hr)} = \left[\frac{\text{reading of measuringcyl(L)}}{\text{time to cover plot(hr)}} \right]$$

- Crop Seedling Emergence

Crop emergence rate was counted for several days at each plot during the mean emergence date (MED) in 1 m length of row, with 3 replications. The emergence rate index (ERI) was calculated directly from emergence counts as follows [18]; 1997 [19]; [20]):

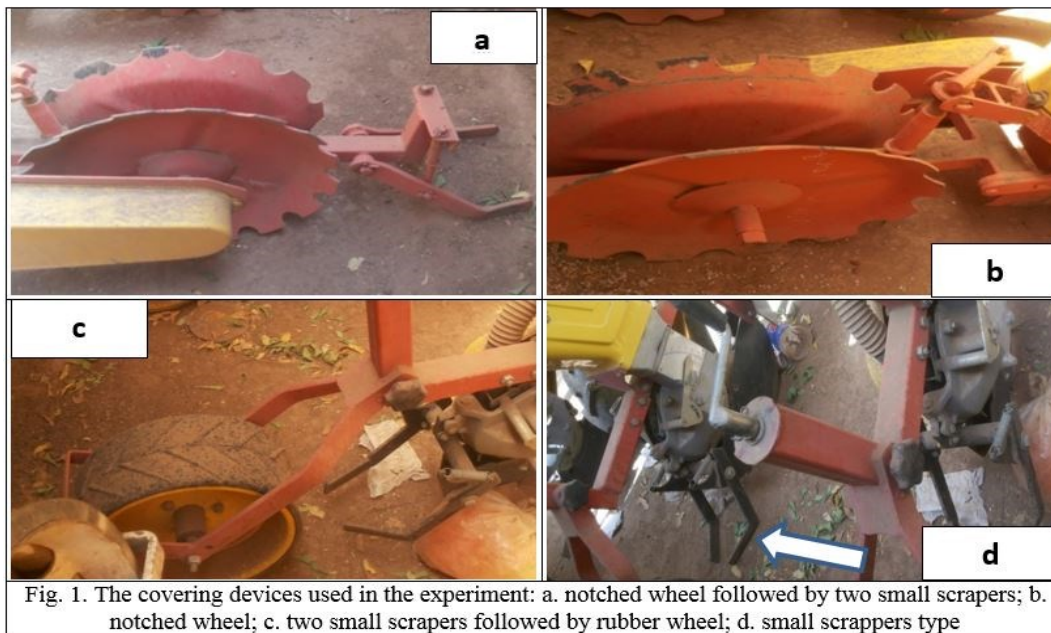
$$MED = \frac{N_1D_1 + N_2D_2 + \dots + N_nD_n}{N_1 + N_2 + \dots + N_n}$$

$$ERI = \frac{\text{Number of emerged plants m}^2}{MED}$$

where N_1, N_2, \dots, N_n is the increase in the number of newly emerged plant stems compared with the previous count and D_1, D_2, \dots, D_n is the number of days after planting.

- *Statistical Analysis:*

Statistical analysis was accomplished by Statistic 8. The data recorded were analyzed statistically using analysis of variance (ANOVA) techniques appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant.



III. RESULTS AND DISCUSSION

In order to determine the effect of seed covering device on wheel slippage, effective field capacity and emergence the variance analysis of variance is given in Table 2.

Table 2 Statistical description of variation for all observed parameters affected by different covering Devices:

Observed Parameters	M. S.	P. Value	F. value	C.V %
Effective field capacity	1.26000	0.0182	7.60	8.04
Fuel Consumption	0.03428	0.7671	0.39	23.61
Slippage	6.25566	0.0254	6.56	36.42
Seed emergence	1224.46	0.0002	44.65	11.76

A. Effects of Different Covering Devices on Effective Field Capacity

The differences in field capacity between different covering devices were statistically significant ($P < 0.05$) (Table 2). Effective field capacity created by operating various seed covering devices was worked out, and such results are presented in Figures 2. An area of 0.161 hectare was cultivated, result indicated the productive time of covering device (1) was 0.48 minutes and non-productive time was 0.41 minutes, producing field capacity of 2.1

ha/hr. Productive time and non-productive time in covering device (2) were 0.47 minutes, 0.42 minutes respectively, producing field capacity of 2.1 ha/h. While productive time of covering device (3) was 0.41 minutes and non-productive time was 0.34 minutes producing field capacity of 2.4 ha/h. productive time and non-productive time for CD4 was 0.52 minutes and 0.39 minutes respectively producing field capacity 1.8ha/hr.

The results indicated that the highest effective field capacity was recorded in covering device (3) while, covering device 4 (CD 4) recorded the lowest value of field capacity. This may be attributed to with an increase in slippage of an implement leads to decrease in an implement speed leading to decreased in effective field capacity. [21] Reported that, a reduction in wheel slippage resulted in increased implements speed.

B. Effects of Different Covering Devices on Travel Reduction (%)

The statistical analysis in Table 2 shows that there are a significant differences ($P > 0.05$) in travel reduction (%) pairwise differences among the various covering devices. Figure 3 shows the effect of covering devices on travel reduction. It could be observed that, the travel reduction (slippage) was increased when the wheel surfaces were smooth. In contrast the CD3 and CD4 recorded the highest

value of the travel reduction, while, the lowest travel reduction was obtained under CD1. In general the travel reduction in CD3 and CD4 was found to be higher than

CD1 and CD2 by 64%. This may be attributed to that when the wheel surfaces were smooth lead to increase the wheel slippage and these results agree with [21].

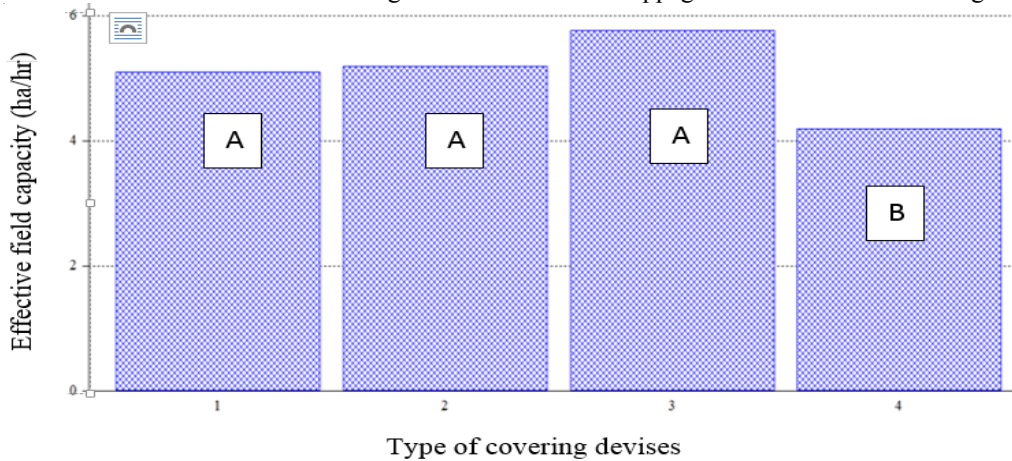


Fig. 2. Means of effective field capacity affected by different covering devices. (Means followed by the different letter differ significantly according to LSD test)

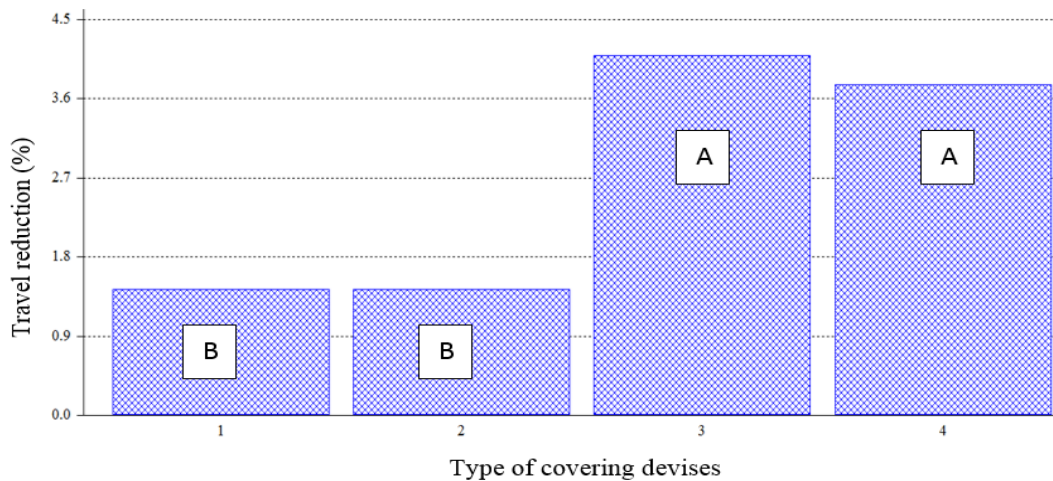


Fig. 3. Means of Travel reduction (%) affected by different covering devices. (Means followed by the different letter differ significantly according to LSD test).

C. Effects of Different Covering Devices on Fuel Consumption:

Over the course of the study, the effect of different covering devices was not significant ($P < 0.05$) on fuel consumption (Table 2). However, it was noted that CD2 had minimum fuel consumption, while, the greatest

fuel consumption was recorded by covering device (CD3 and CD4). Covering device (CD1) gave 1.38 lit/hr, while covering device (CD2) recorded 1.25 lit/hr or 8% and 16.7% less fuel consumption than Covering device (CD3) and (CD4) respectively (Fig. 4).

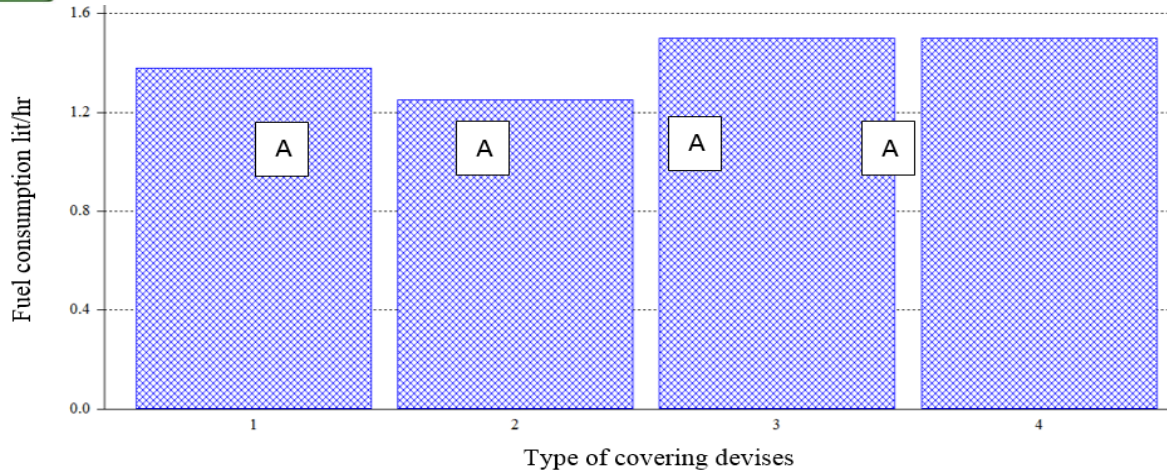


Fig. 4. Means of fuel consumption affected by different covering devices.

(Means followed by the different letter differ significantly according to LSD test)

D. Effects of different Covering devices on Seedling Emergence

The variance analysis of the average ERI values of crop is presented in Table 3. Average ERI values and comparison of mean using LSD test are shown in Fig (5).

The effect of seed Covering Devices (C.D) on the ERI was statistically highly significant. The highest ERI (69.540) was obtained from covering device (1) CD1, while covering device 3(CD3) gave the lowest ERI (26.8). Covering device 2 (CD2) and covering device (3) produced similar values. The ERI value with (CD4) was greater compared to (CD2) and (CD3) by 43.4% and 48.7% respectively, while it was lower than (CD1) by

24.8%. The (CD1) had the highest ERI, this result agree with findings by [22], [23] and [24]. The lower ERI under (CD3) compared to (CD1) may be because larger aggregates caused seedling entrapment (Durr and Jean-Noel, 2000) as well as poorer seed-soil contact. [19] Reported that ERI decreased with decreasing aggregate mean weight diameter. Similarly, he pointed out that emergence is more likely to occur in finer (less than 1 mm and 1-2 mm) seedbeds than in coarser (5-15 mm) seedbeds, and at the highest initial soil water content used. The effect of rotary harrow on ERI was not statistically significant.

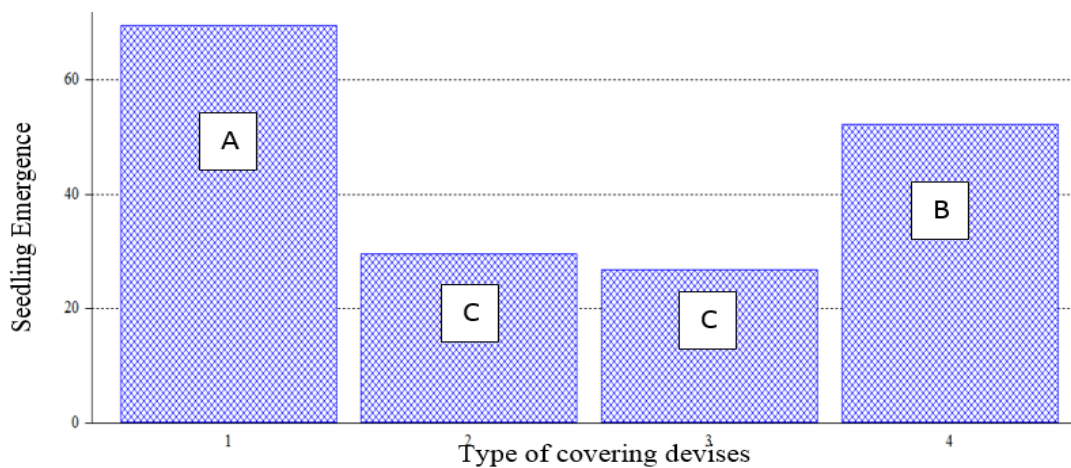


Fig. 5: Means of Seedling Emergence affected by different covering devices.

(Means followed by the different letter differ significantly according to LSD test)

IV. CONCLUSIONS

- 1) Effective field capacity, wheel slippage, fuel consumption and Seedling Emergence at different covering devices on a light clay soil were measured and evaluated.
- 2) Fuel consumption was not significantly affected by covering devices. The lowest fuel consumption FC was recorded in covering device (2), while the highest (FC) was recorded in covering device (4).
- 3) There were significant differences in wheel slippage (%) among the covering devices. while slippage under covering device (3) was greater than the other covering devices.
- 4) The differences in field capacity as well as seedling emergence between different covering devices were statistically significant. The highest field capacity was recorded in covering device (3), while covering device (1) recorded the highest value of seedling emergence (ERI).

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