Performance of conduct field evaluation of strip-till seed-drill for wheat crop

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ABSTRACT

Studies were conducted for field evaluation of strip-till seed-drill for wheat crop. The study was conducted at Research farm, SHUATS. Agronomic data recorded during the field evaluation showed that the fuel consumption and slip were 9.02 l/ha and 1.706 % (minimum) at 2.5 km/hr forward speed and 3.5 cm depth whereas field efficiency was found to be 78.42 % (maximum) at corresponding speed and depth. The field capacity was found to be proper at 2.5 km/hr forward speed and 4.5 cm depth. The cost of seeding with strip till seed drill was calculated to be Rs.1258.97/ha and seeding with conventional method (tillage and broadcasting) costs Rs.1722.34/ha. The net saving by strip till seed drill was calculated to be Rs.463.36/ha in comparison to conventional method of sowing.

Key wards: *Conduct field evaluation of strip-till seed-drill*

Introduction

Agriculture is the backbone of national economy. It is the means of livelihood for majority of the population, main source of GDP, income and employment opportunities of the country. Agriculture contributes to about 38 per cent to national GDP and provides part-and full-time employment opportunities to 80 percent of its population. Rice and wheat are major cereal crops which contribute to about 70 per cent of total food grain production of the country with an area of 12 M ha under this cropping system.

The major challenge of the agricultural system is to feed the growing population of the country. However, the long-term fertility of rice wheat system indicates stagnating and declining yields of rice and wheat crops.

Even though overall national yield data of these cereal crops indicates that it is increasing slowly, yet, the factor productivity and profitability is declining due to soil fertility decline, weed problem, disease and insects, labour /power scarcity, high cost of inputs.

Strip-till is a conservation system that uses a minimum tillage. It combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till by disturbing only the portion of the soil that is to contain the seed row. This type of tillage is performed with special equipment and can require the farmer to make multiple trips, depending on the strip-till implement used, and field conditions. Each row that has been strip-tilled is usually about eight to ten inches wide.

Materials and Methods

The study was undertaken to evaluate the performance of strip till seed drill for sowing of wheat crop in Allahabad region. Field trials of strip till seed drill were conducted in research farm SHUATS.

A tractor drawn strip till seed drill was developed by National Agro Industries, Ludhiana. It consists of a rotary blade attachment, operating in front of the furrow openers. The rotary attachment consists of a frame with nine flanges attached to the rotor. Each flange has C-type blades, made from medium carbon steel or alloy steel, hardened and tempered to suitable hardness. These blades require less power and provide a coarse finish for better moisture penetration. Power transmission unit consists of rotor shaft, speed reduction gear box and chain and sprocket drive. Tractor pto supplies power to rotor shaft through the gear box and chain-sprocket drive. The strip till seed drill is intended to be used with tractor having 35-75hp, 540 or 1000 pto speed, rotor speed 300 rpm and working width 127 to 229 cm. The drive is via the universal joint assembly, safety clutch, speed reduction gear box and heavy duty chain drive to rotor. A sheet cover is there for safety purpose.

The strip till seed drill also consists of a seed box and fertilizer box for placement of seeds and fertilizer at proper depth. The frame of seed box is made up of angle iron. All the parts are connected to the frame whereas furrow openers are suspended below its back. The seed box is made of galvanized iron or sheet metal. A power driven agitator is provided to check the seed from bridging over as they fall out. The seed box consists of fluted feed mechanism to drop desired amount of seed on the ground with uniform distribution pattern. It consists of fluted roller, feed cut-off and adjustable gate for different size of grains. The flutted roller carries grooves throughout the periphery. As it rotates, the grooves of upper part comes down with seeds, and deliver then into the seed tube, from where it goes to boot and then to the furrow opened by the furrow opener. The seed rate is adjusted by varying the exposed part of roller inside the cup feed with the help of adjustable lever.

The performance of seed drill varies with the condition of field, machine and operator. Therefore, the conditions of test are stated below:

Condition of field:

Moist soil

Condition of seed:

Name and variety of seed: wheat, PBW 343

Condition of machine and operator:

- Source of power 35hp tractor
- Adjustment of working parts of machine
  adjustment for seed rate@ 100 kg/ha
- Travelling speed: 2.5 km/hr, 3 km/hr, 3.5 km/hr

For conducting experiment, the machine was operated at different speed and depth and for each operation dependent variable such as effective field capacity, field efficiency, fuel consumption and wheel slippage were recorded.Experiments were repeated for three different speed and depth of operation and their corresponding values were recorded.

Field capacity and field efficiency:

The effective field capacity is calculated by recording the actual area covered by the implement, based on its total time consumed and its width.

$$Efc = \frac{A}{TP+T1} \text{............(1)}$$

Theoretical field capacity is rate of field coverage of the implement, based on 100% of time at rated speed and covering 100% of its rated width.

$$Tfc = \frac{W \times S}{10} \text{...........(2)}$$

Field Efficiency is the ratio of effective field capacity to theoretical field capacity, expressed in %.

$$Ef = \frac{Efc}{Tfc} \text{............(3)}$$

where,

Efc = Effective field capacity, ha/hr
Tfc = Theoretical field capacity, ha/hr
Ef = Field efficiency, %
A = Area covered, ha
TP = Productive time, hr
T1 = Non productive time, hr
W = Effective working width, m
S = Speed of operation, km/hr

Fuel consumption:

It is a dependent variable that directly shows the economy of the operation with different speed and depth. It was measured by top-up method. The tank is filled to full capacity before and after the test. Amount of refilling after the test is the fuel consumption for the test.

Wheel Slippage:

Wheel slippage is also called speed reduction. Due to moisture present in the soil, wheel slippage occurs. Wheel slippage is an important parameter which influences field capacity.

To calculate wheel slip, a mark on the rear wheel of the tractor was put to count the number of revolution. The revolutions covered by the tractor rear wheel in 25mdistance was counted and time taken by the tractor to cover 25m distance was measured using a stop watch and hence, wheel slip was calculated by using the formula given below:

S (%) = (1- $\frac{v_a}{v_t}$)............(4)

where,

S= Wheel slip (%)
v_a= Actual speed of travel (km/hr)
v_t= Theoretical speed (km/hr)

Depth of operation:

The depth of sowing was measured at different location with the help of scale and average was taken.

Speed of operation:

To calculate speed of operation, two poles 20 m apart were placed approximately in the middle of test run. The speed was calculated from the time required for the machine to travel the distance of 20 m.

Time required:

Total time for each operation and time required in turning was recorded in each operation with the help of stop watch and after completion, total time lost in turning and total time of operation was calculated.

To study the performance evaluation of strip till see drill, the variables under study are classified as:

- Independent variables
- Dependent variables

Independent variables:

Forward speeds, depth of sowing were taken as independent variables.
Levels of independent variables under study:
Forward speed (km/hr): S1 = 2.5km/hr, S2 = 3km/hr, S3= 3.5km/hr.
Depth of sowing (cm): D1=3.5cm, D2 = 4.5cm, D3 = 5.5cm

Dependent variables:

Effective field capacity, field efficiency, fuel consumption & wheel slippage were taken as dependent variables.

Result and Discussion

This chapter deals with the result of performance evaluation of strip till seed drill obtained during the field tests. The experiments were conducted in the field to evaluate the performance of strip till seed drill. The results obtained have been analyzed and discussed under the following headings:
The performance of the strip till seed drill has been explained as under the following sub heads:

- Speed of operation
- Depth of sowing
- Effective field capacity
- Field efficiency
- Fuel consumption
- Wheel slippage
- Labour requirements
- Cost of operation

Speed of operation:

The speed of operation was considered as an independent variable to see its effect on various performance parameters like field capacity, field efficiency etc. of. Three speed of operation of strip till seed drillweremeasured and taken as 2.5, 3 and 3.5 km/hr.

Depth of sowing:

The depth of sowing was also considered as an independent variable. Three depths of sowing were measured and taken as 3.5cm, 4.5cm and 5.5cmto see its effect on various performance parameters like field capacity, field efficiency, fuel consumption and wheel slippage and its interaction with speed on the following parameters.

Effective Field capacity:

The effective field capacity obtained at three different forward speeds and depths of sowing is given in table 4.5, 4.6 and 4.7.The effective field capacity was found to be 0.45 ha/hr (maximum) at forward speed of 3.5 km/hr and 4.5 cm depth of sowing and 0.383 ha/hr (minimum) at 2.5 km/hr forward speed and 4.5 cm depth. Since, effective field capacity depends upon time and as the depth increases, more time is required for sowing and hence, it decreases.

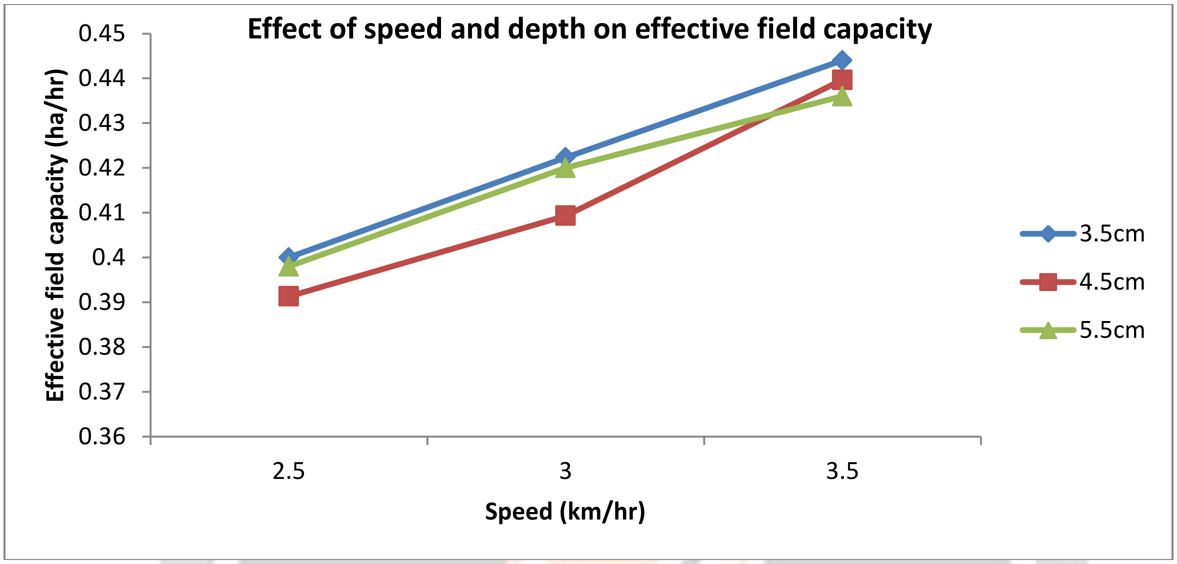

Fig.4.1 Graph between effective field capacity and speedat different depths of sowing

The effect of speed and depth was also statistically analysed using ANOVA technique. The speed independently affected the field capacity (with $F_{calculated}$ higher than $F_{tabulated}$at p=0.05) but there was no significant effect of depth on field capacity.

Table 4.1 ANOVA for effective field capacityat different speeds and depths

Source of Variation	SS	Df	MS	F	P-value	F critical
Speed	0.010	2	0.005	22.47*	1.28E-05	3.554
Depth	0.001	2	0.001	1.264	0.306	3.554
Interaction	0.001	4	7.66E-05	0.319	0.861	2.927
Within	0.004	18	0.001			
Total	0.016	26				

* Significant value

Field efficiency:

The data for field efficiency ofstrip till seed drill is given in the table 4.5, 4.6 and 4.7. It is found to be 78.42% (maximum) at 2.5 km/hr speed and 3.5 cm depth of sowing and 57.69% (minimum) at 3.5 km/hr speed and 5.5 cm depth i.e. field efficiency of strip till seed drill decreases with increase in speed and depth. This is obviously due to the reason that the large amount of time is lost in sowing as the depth increases.

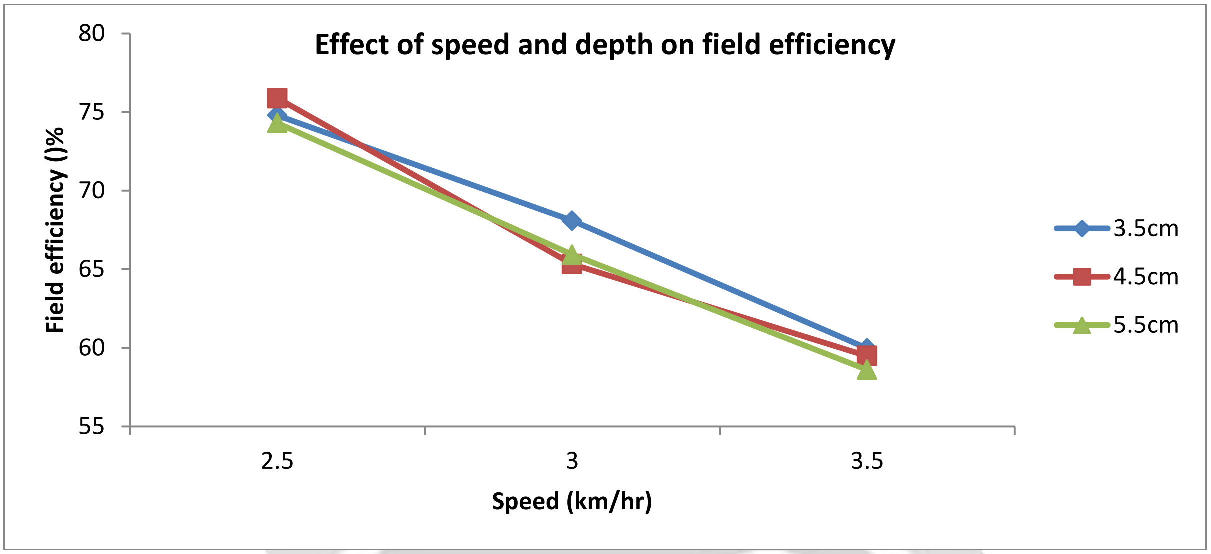

Fig.4.2 Graph between field efficiency and speed at different depths of sowing

The effect of speed and depth was statistically analysed using ANOVA technique**.** The speed independently affected the field efficiency (with $F_{calculated}$ higher than $F_{tabulated}$at p=0.05)but there was no significant effect of depth on field efficiency.

Table 4.2 ANOVA for field efficiencyat different speeds and depths

Source of Variation	SS	Df	MS	F	P-value	F critical
Speed	1271.365	2	635.683	96.075*	2.48E-10	3.554
Depth	16.033	2	8.017	1.212	0.321	3.554
Interaction	8.044	4	2.011	0.304	0.871	2.927
Within	119.096	18	6.616			
Total	1414.54	26				

* Significant value

Fuel consumption

From the data given in the table 4.5, 4.6 and 4.7, fuel consumption was recorded to be 9.02 l/ha (minimum) at operating speed of 2.5 km/hr and 3.5 cm depth. However, the maximum fuel consumption was recorded to be 12.8 l/ha (maximum) at operating speed of 3.5 km/hr and 5.5 cm depth. This is due to the reason that as the speed and depth increased, more time was consumed in sowing. Hence, more fuel was consumed.

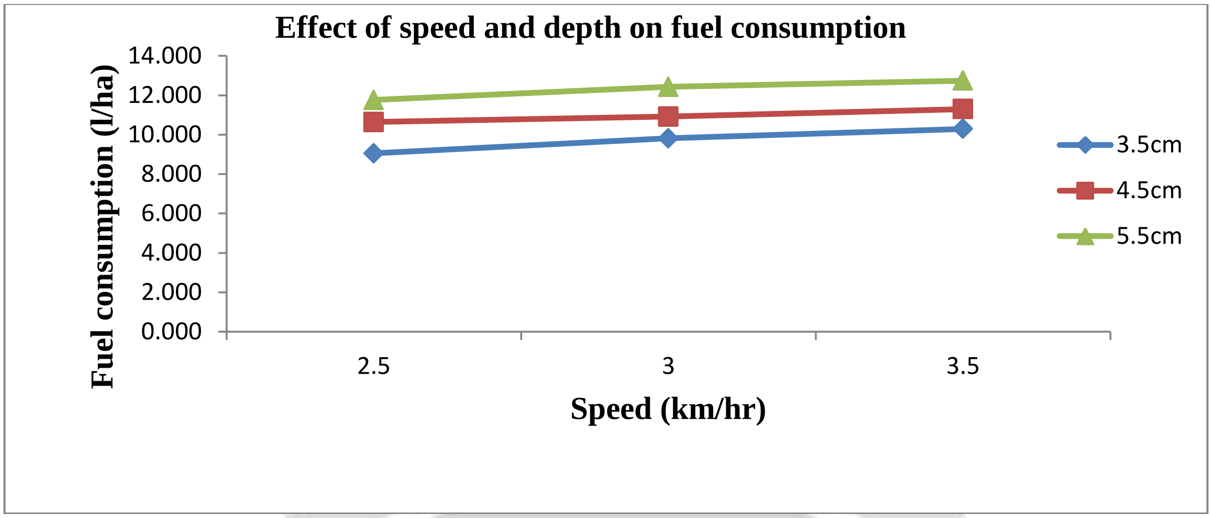

Fig.4.4 Graph between fuel consumption and speed at different depths of sowing

The effect of speed and depth was statistically analysed using ANOVA technique**.** The speed and depth independently affected fuel consumption (with $F_{calculated}$ higher than $F_{tabulated}$at p=0.05).Also,there was significant effect of the interaction of speed and depth on fuel consumption.

Table 4.3 ANOVA for fuel consumptionat different speeds and depths

Source of Variation	SS	Df	MS	F	P-value	F critical
Speed	4.204	2	2.102	765.842*	3.85E-18	3.554
Depth	30.182	2	15.091	5498.773*	8.31E-26	3.554
Interaction	0.314	4	0.079	28.642*	1.38E-07	2.927
Within	0.0494	18	0.003			
Total	34.7496	26				

* Significant value

Wheel slippage:

The data for wheel slippage is given in the table 4.5, 4.6 and 4.7for different speed and depth. Wheel slippage was found to be 1.709% (minimum) at 2.5 km/hr and 3.5 cm depth of sowing and 8.52% (maximum) at 3.5 km/hr forward speed and5.5cm depth. As the depth of sowing and speed increased, the number of revolutions of rear wheel increased to cover same field and more time was consumed in sowing. Therefore, wheel slippage increased.

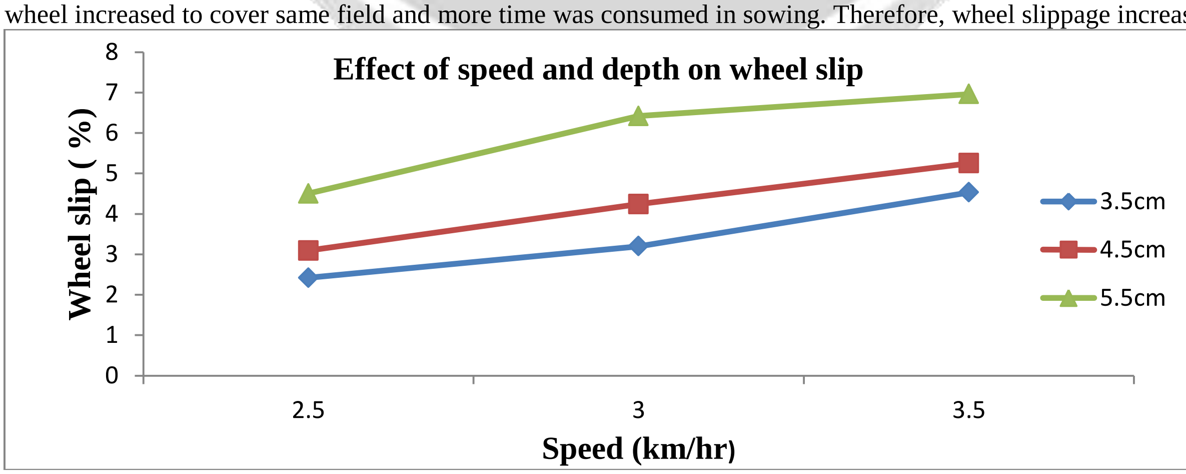

Fig.4.4 Graph between wheel slip and speed at different depths of sowing

The effect of speed and depth was statistically analysed using ANOVA technique**.** The speed and depth independently affected wheel slip (with $F_{calculated}$ higher than $F_{tabulated}$at p=0.05) but there was no significant effect of the interaction of speed and depth on wheel slip.

Table 4.4 ANOVA for wheel slip at different speeds and depths

Source of Variation	SS	Df	MS	F	P-value	F critical
Speed	22.828	2	11.414	7.764*	0.0037	3.555
Depth	31.387	2	15.694	10.675*	0.0009	3.555
Interaction	1.063	4	0.266	0.181	0.9454	2.928
Within	26.463	18	1.470			
Total	81.742	26				

* Significant value

S.No.	Speed (km/hr)	Depth (cm)	Theoretical Field Capacity (ha/hr)	Effective Field Capacity (ha/hr)	Field Efficiency (%)	Wheel Slippage (%)	Fuel Consumption (l/ha)
1.	2.5	3.5	0.512	0.400	78.12	2.429	9.09
2.	3	3.5	0.615	0.419	68.05	2.462	9.86
3.	3.5	3.5	0.727	0.429	58.98	3.672	10.25
4.	2.5	4.5	0.516	0.391	75.83	3.111	10.74
5.	3	4.5	0.632	0.409	64.73	5.063	10.90
6.	3.5	4.5	0.746	0.450	60.32	6.174	11.29
7.	2.5	5.5	0.524	0.412	74.06	4.597	11.74
8.	3	5.5	0.644	0.423	69.84	6.880	12.40
9.	3.5	5.5	0.750	0.434	63.19	6.621	12.68

MEASUREMENTS FOR STRIP TILL SEED DRILL
Table 4.5 REPLICATION-1

Table 4.6 REPLICATION-2

S.No.	Speed (km/hr)	Depth (cm)	Theoretical Field Capacity (ha/hr)	Effective Field Capacity (ha/hr)	Field Efficiency (%)	Wheel Slippage (%)	Fuel Consumption (l/ha)
1.	2.5	3.5	0.516	0.391	75.83	3.111	9.02
2.	3	3.5	0.631	0.419	66.35	4.901	9.75
3.	3.5	3.5	0.743	0.429	57.69	5.766	10.30
4.	2.5	4.5	0.520	0.383	73.72	3.784	10.54
5.	3	4.5	0.633	0.400	63.19	5.217	10.95
6.	3.5	4.5	0.741	0.419	56.47	5.575	11.32
7.	2.5	5.5	0.531	0.391	73.69	5.802	11.78
8.	3	5.5	0.647	0.409	63.26	7.323	12.43
9.	3.5	5.5	0.765	0.442	60.32	8.520	12.75

Table 4.7 REPLICATION-3

S.No.	Speed (km/hr)	Depth (cm)	Theoretical Field Capacity (ha/hr)	Effective Field Capacity (ha/hr)	Field Efficiency (%)	Wheel Slippage (%)	Fuel Consumption (l/ha)
1.	2.5	3.5	0.509	0.409	78.42	1.706	9.05
2.	3	3.5	0.614	0.429	69.84	2.224	9.80
3.	3.5	3.5	0.730	0.462	63.18	4.164	10.34
4.	2.5	4.5	0.512	0.400	78.05	2.429	10.65
5.	3	4.5	0.615	0.419	68.04	2.462	10.92
6.	3.5	4.5	0.729	0.450	61.71	3.992	11.30
7.	2.5	5.5	0.516	0.391	75.82	3.111	11.77
8.	3	5.5	0.632	0.409	64.73	5.063	12.45
9.	3.5	5.5	0.743	0.429	57.69	5.766	12.80

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