PERFORMANCE 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 to study the effect of depths of sowing (cm) and speed of operations (km/hr) on various dependent parameters like field capacity(ha/hr), field efficiency(%), fuel consumption(l/ha) and wheel slippage (%). The study also revealed that depth of sowing and speed of operation significantly affected fuel consumption, wheel slippage, field capacity and field efficiency.The study was conducted at Research farm, SU Gangoh. 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.

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 Mha 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.

In this context, it is realized that conservation agriculture (CA) could be an ultimate solution to enhance the production and productivity and maintaining the sustainability of the agro-ecosystem.

To move forward CA, tillage is the major component of the system. Conservation tillage is a set of practices that leave crop residues on the surface which increases water infiltration and reduces erosion. It is a practice used in conventional agriculture to reduce the effects of tillage on soil erosion. However, it still depends on tillage as the structure-forming element in the soil. Nevertheless, conservation tillage practices such as zero tillage practices can be transition steps towards CA (FAO, conservation agriculture website).

Drilling consists of dropping the seeds in furrow lines in a continuous flow and covering them with soil. Seed metering may be done manually or mechanically. The no. of rows planted may be one or more. This method is helpful in achieving proper depth, proper spacing and proper amount of seeds to be sown in the field.

Drilling can be done by:

- Sowing behind the plough
- Bullock drawn seed drill
- Tractor drawn seed drill

Seed drill is a machine for placing the seeds in a continuous flow in furrow at uniform rate and at controlled depth with or without the arrangement of covering them with soil. This can only be done when the weather and soil conditions are right as the seeds have to be sown at the correct depth and immediately covered.

Functions of seed drill:

- To carry the seeds
- To open furrow to uniform depth
- To meter the seeds
- To place the seed in furrows in an acceptable pattern
- To cover the seeds and compact the soil around the seed

Transplanting consists of preparing seedlings in nursery and then planting these seedlings in the prepared field. It is commonly used for paddy, vegetables and flowers. It is very time consuming operation. Equipment used for transplanting is called transplanter.

Seed dropping behind the plough is a very common method used in villages. It is used for seeds like maize, gram peas, wheat and barley. A man drops seeds in furrows behind the plough and other man handles the plough and the bullocks. This is slow and laborious method.

Keeping above facts in view, study was conducted to see the performance evaluation of strip till seed drill method by sowing of wheat and to compare economy and energy consumption in strip till seed-drill with broadcasting method.

PROBLEM STATEMENT:

Strip till seed drill is suitable for both dry and wet conditions and also for incorporating straw and green manure in the field. Though the machine is reported to be an efficient one, it is not popular among the farmers of the region. So, there is a need to evaluate the performance of this machine and compare its working with traditional method of broadcasting.

OBJECTIVES:

The study was conducted with following objectives:

- To conduct field evaluation of strip till seed drill for wheat crop.
- To study the effect of depth of sowing and speed of operation on effective field capacity, field efficiency, fuel consumption and wheel slippage.
- To compare the cost of operation of strip till seed drill with traditional method of broadcasting.

MATERIALS AND METHODS

The study was undertaken to evaluate the performance of strip till seed drill for sowing of wheat crop in Saharanpur region. Field trials of strip till seed drill were conducted in research farm SU,Gangoh.
The contents of this chapter are discussed under following heads:

3.1 Description of strip till seed drill

3.2 Variables under study

3.3 Techniques for measuring the variables

3.4 Experimental procedure

3.5 Analysis of experimental data

3.1 DESCRIPTION OF MACHINE:

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. The pto of the tractor drives the rotavator. 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.

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3.2 VARIABLES UNDER STUDY:

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

- Independent variables
- Dependent variables

3.2.1 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

3.2.2 Dependent variables:

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

3.3 TECHNIQUES FOR MEASURING THE VARIABLES:

3.3.1 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.

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

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.

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

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

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

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

3.3.2 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.

3.3.3 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:

$$\textbf{S (\%)} = \left(1 - \frac{v_a}{v_t}\right) \quad \text{............(4)}$$

where,

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

3.3.4 Depth of operation:

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

3.3.5 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.

3.3.6 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.

3.3.7 Cost of operation:

Cost analysis is done by calculating fixed cost and variable cost.

3.3.7.1 Fixed cost:

- Depreciation(D) = $\frac{(C-S)}{L \times H}$, INR/hr **……….(5)**
- Interest (I) =$\frac{C+S}{2} \times \left(\frac{i}{H}\right)$, INR/hr **……….(6)**
- Repair and maintenance cost @ 10% of initial cost per year

where,

C = Initial cost,
S = Salvage value,
i = Rate of interest
H = Working hrs per yr

3.3.7.2 Variable cost:

- Fuel cost/hr
- Lubricants @ 30% of fuel cost
- Wages/hr

Table 3.1 Instruments used during the experiment

S.No.	NAME OF INSTRUMENT	PURPOSE	LEAST COUNT	CAPACITY
1.	Measuring cylinder	Fuel consumption	1 ml	250 ml
2.	Stop watch	Time	0.1 sec	60 min
3.	Measuring tape	Linear distance	1 cm	30 m
4.	Measuring scale	Linear distance	1 mm	30 cm

3.4 EXPERIMENTAL PROCEDURE:

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

3.4.1 Condition of field:
Moist soil

3.4.2 Condition of seed:
Name and variety of seed: wheat, PBW 343

3.4.3 Condition of machine and operator:

- Source of power 35 hp 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.

3.5 ANALYSIS OF EXPERIMENTAL DATA:

The observations on different parameters were collected and analysed using ANOVA technique.

RESULTS AND DISCUSSION

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

4.1 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 drill were measured and taken as 2.5, 3 and 3.5 km/hr.

4.2 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 5.5cm to 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.

4.3 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.

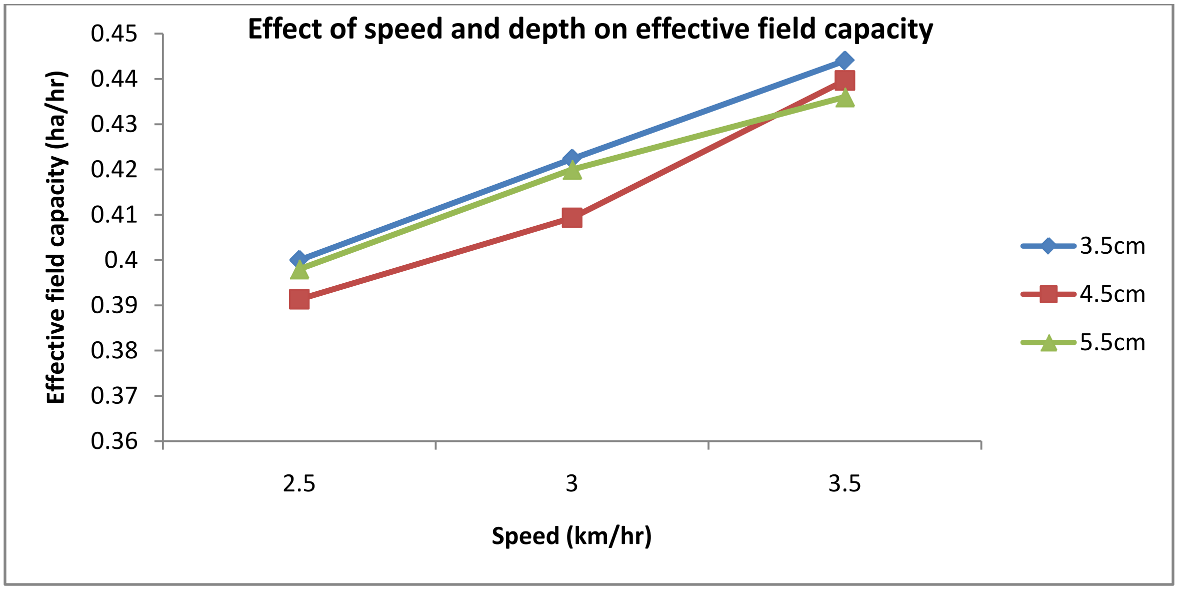

Fig.4.1 Graph between effective field capacity and speedat different depths of sowing

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

4.4 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.

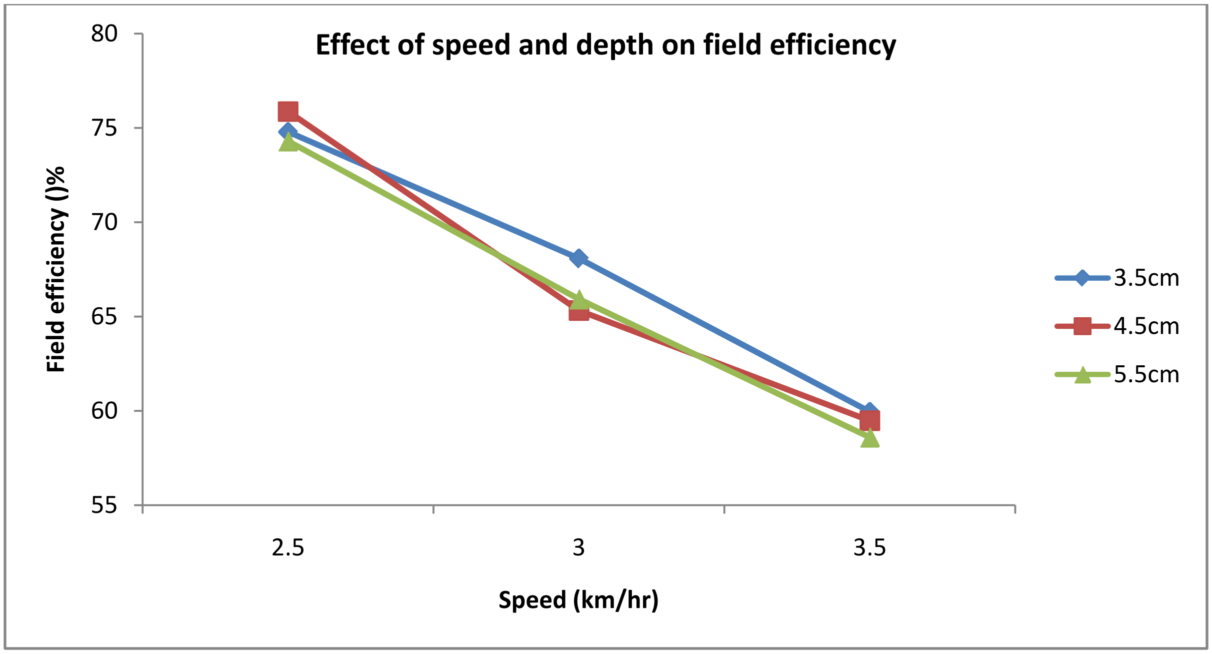

Fig.4.2 Graph between field efficiency and speed at different depths of sowing

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

4.5 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.

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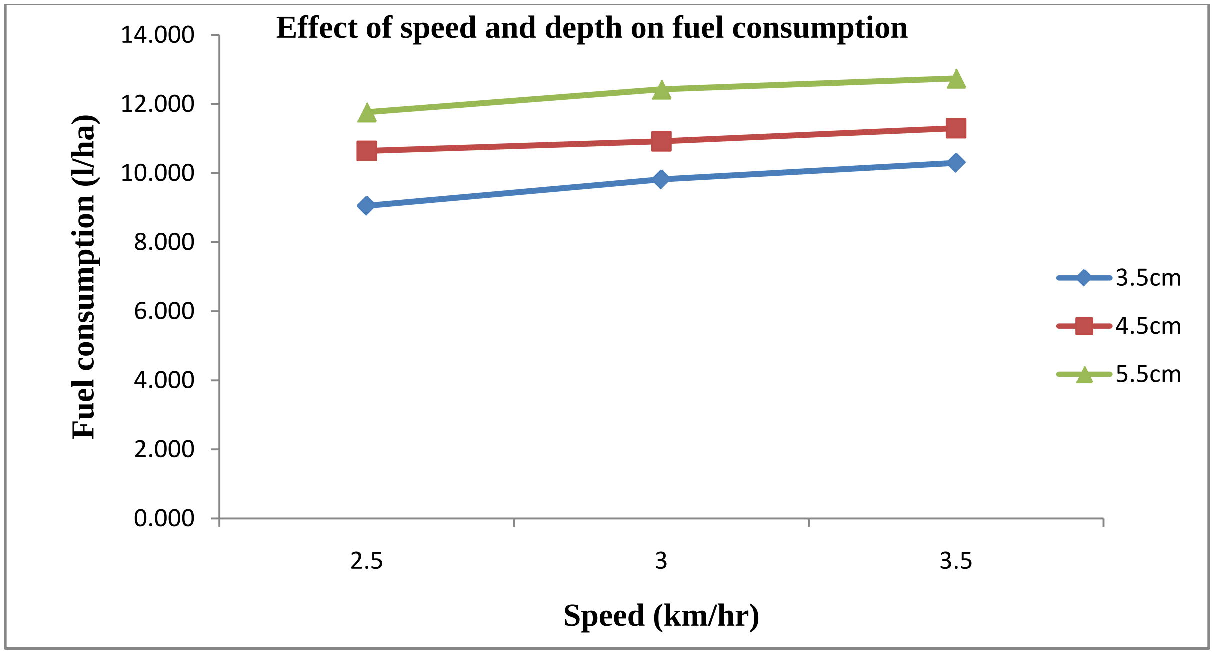

Fig.4.4 Graph between fuel consumption and speed at different depths of sowing

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

4.6 Wheel slippage:

The data for wheel slippage is given in the table 4.5, 4.6 and 4.7 for 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.

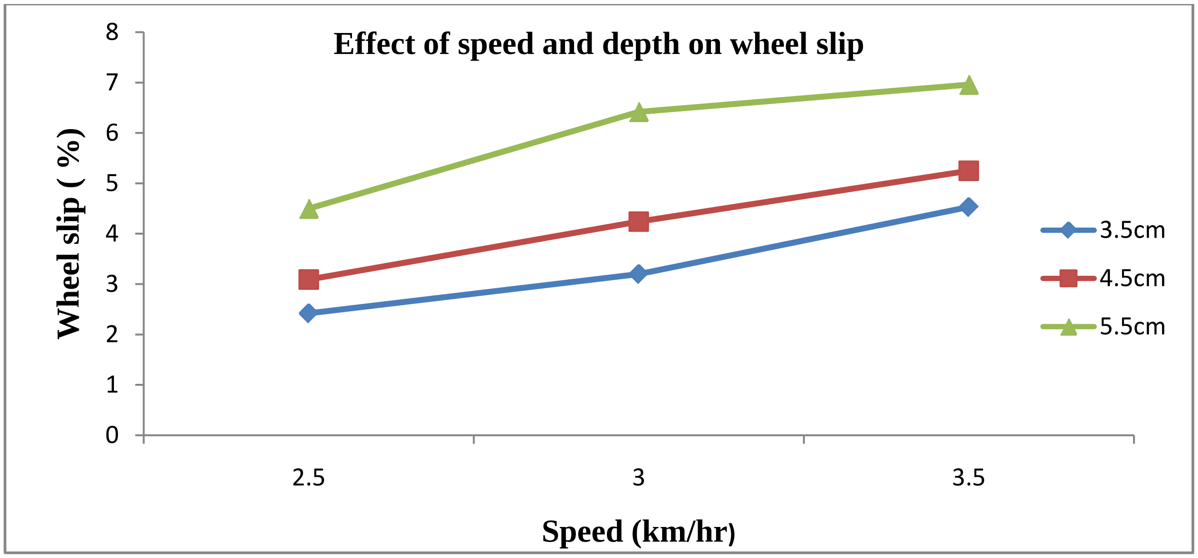

Fig.4.4 Graph between wheel slip and speed at different depths of sowing

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

4.7 Labour requirements:

The labour requirements for conventional method required a tractor operator to operator the rotavator machine for land preparation andone skilled labour for broadcasting of seeds. In conventional method, labour required 8 hours to cover 1 hectare land. On the other hand, strip till seed drill required only one tractor operator for seeding.

4.8 Cost of operation:

The complete cost analysis of the strip till seed drill and conventional seeding is shown in table4.8 and 4.9. The total cost of seeding withstrip till seed drill machine was found to be Rs. 1258.97 per hectare and seeding with conventional method was Rs. 1722.34 per hectare. It revealed that strip till seed drill is more economical and less time consuming thanseeding with conventional method.

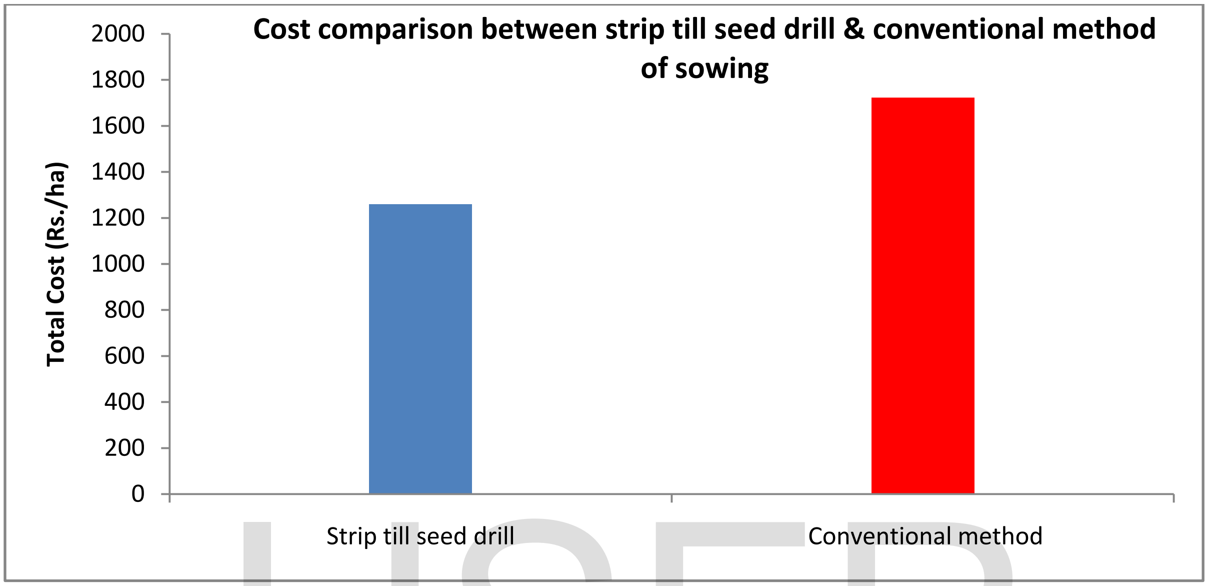

Fig. 4.5 Graph for comparison between strip till seed drill and conventional method of sowing

MEASUREMENTS FOR STRIP TILL SEED DRILL

Table 4.5 REPLICATION-1

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 4.6REPLICATION-2

S.No.	Speed (km/hr)	Depth (cm)	TheoreticalField 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

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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

Table 4.7 REPLICATION-3COST ECONOMIC COMPARISION BETWEEN STRIP TILL SEED DRILL AND

CONVENTIONAL METHOD OF SOWING

Table 4.8 Cost evaluation in land preparation and broadcasting

	FIXED COST			VARIABLE COST				Cost INR/hr	Cost INR/ha
	Depreciation INR/hr	Interest INR/hr	Repair & maintenance INR/hr	Fuel cost INR/hr	Lubri-cation INR/hr	Wages INR/hr	Operator cost INR/hr		
Rotavator	35.63	22.64	31.67					89.94	224.85
Tractor	45	35.75	50	240	72		56.25	499	1247.5
Broadcasting								31.25	250
Total									1722.35

Table 4.9 Cost evaluation of strip till seed drill

	FIXED COST			VARIABLE COST				Cost INR/hr	Cost INR /ha
	Depreciation INR/hr	Interest INR/hr	Repair & maintenance INR/hr	Fuel cost INR/hr	Lubri-cation INR/hr	Wages INR/hr	Operator cost INR/hr		
Strip till seed drill	15	11.92	16.67					43.59	108.97
Tractor	45	35.75	50	210	63		56.25	460	1150
Total									1258.97

CONCLUSION

The summary of the work done on field evaluation of strip till seed drill for sowing of wheat crop.The study was conducted at the research farm, SU Gangoh. For field evaluation of strip till seed drill, Regional Network of Agricultural Machinery test code was adopted. The test was replicated three times.

Forward speed and depth of sowing were taken as independent variables while wheel slippage, effective field capacity, field efficiency and fuel consumption were taken as dependent variables.

The wheel slippage and fuel consumption at 2.5 km/hr forward speed and 3.5 cm depth of sowing were found to be 1.709 % and 9.02 l/ha (minimum). However, largest value of field efficiency was found to be 78.42% at corresponding speed and depth. The effective field capacity was recorded to be 0.462 ha/hr (maximum) at 3.5 km/hr speed and 5.5 cm depth of sowing.

The values of different parameters were calculated for strip till seed drill. The mean values of effectivefield capacity, field efficiency, wheel slippage and fuel consumption came to be 0.419 ha/hr, 67.67%, 4.515% and 10.99 l/ha respectively.

Based on the present study the following conclusions were drawn:

1. The wheel slippage of drive wheel of tractor increased with increase in forward speed and depth of operation.

2. Field capacity increased with increase in forward speed.

3. The fuel consumption increased linearly with increase in forward speed and depth of sowing.

4. Field efficiency decreases with increase in forward speed and depth of sowing.

5.The net saving by strip till seed drill was calculated to be Rs.463.36/ha in comparison to conventional method of sowing

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