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Research Article

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Influence of different types of furrow openers on soil disruption for tractor drawn seed drill

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Abstract Optimum emergence is necessary to attain maximum crop yields. Optimum emergence of seed is depend on performance of furrow openers for tractor drawn seed drill. An experiment was conducted at instructional farm of College of Technology and Engineering, Udaipur containing sandy loam sand to assess the influence of different commercially available seed drill furrow openers on soil disruption for tractor drawn seed drill. The furrow openers compared were a Shoe type and a Shovel type furrow opener. These furrow openers were driven in the soil by tractor at three different forward speeds 4 km/h, 5 km/h and 6 km/h and the resulting soil disruptions were measured by soil Profilometer. Gravimetric soil water content of 11.1% (d.b.), soil bulk density 1.66 g/cc and a constant working depth (50 mm) were considered in the experiment. In the both furrow openers soil disruption increased with increasing operational forward speed of seed drill. Soil disruption was more for shovel type furrow opener with comparison to shoe type furrow opener because of wider design of shovel type furrow opener.

Keywords Furrow openers; Spoil and trench profile; Soil bulk density; Soil water content.

Introduction

India is predominately an agricultural country and it continues to remain a significant sector of the Indian economy. India has a total geographical area of 329 million hectares and a population of over 1.237 billion (2012), with agriculture still having the main occupation of 72.5% Indian population. Agriculture contributes 26% of GDP (Gross domestic product, 1.842 trillion USD - 2012) and provides 60% of employment. The population has been increasing at the rate of 1.3% annually (2012) and will be about 1.32 billion by the end of 2030. This will require 240 to 300 million tones of food grain to feed the population. The net sown area is 142 million hectares out of which the net irrigated area covers 45.5% and the remaining 54.5% is rain fed. This has to be increased from the available resources and the second green revolution from the dry land [1].

Agricultural Mechanization in India

The mechanization of Indian agriculture has played dominate role in increasing agricultural production, productivity and profitability by timely farm operations, saving in cost of operation, maximizing utilization efficiency of agricultural inputs by their judicious applications and reducing losses. The growth of agricultural mechanization has been rapid during last four decades. The newly developed appropriate technology of farm mechanization with improvement in existing design, newer material and production techniques will cater the needs of today's farm [2]. The growth in large scale adoption of agriculture tools and machinery in the country has been possible due to efforts not only by organized sectors but also by small village and craftsman scale industries. Indian agriculture continues to be dependent upon human (agricultural workers population 234

million in 2007-08) and draught animal power (54 million in 2007-08). Adoption of tractors has been on the increase [1]. At present large number of animal drawn and tractor drawn implements are manufactured by local firms. Improved implement increases the output and quality of work. It includes seed drills, seed-cum- fertilizer drills, ploughs, cultivators, harrows and many other implements.

A number of machines and equipment suitable for different farm operations suited to different agro-climatic regions and categories of farm have been developed. Tractor production of 3.46 million during the year 2007-08 in the country reflects the increase of use of tractors for various operations. A raising trend of about 22.3 per cent in growth of power operated agricultural machinery such as seed drill, power sprayer/ duster, M.B. and disc plough, disc harrow, cultivator, planter and thresher from 1991-92 to 2000-2001 suggests the inclination of Indian farmers towards mechanizing agricultural operations [3]. The total number of available power operated machines 15.8 million during the year 2007-08 in the country shows remarkable progress in agricultural mechanization.

Tillage is an energy intensive farm operation consuming about 40 per cent of the total energy input required for crop production. Sowing is one of the most important farm operations. Seed drill is used for sowing seeds of various sizes viz. wheat, gram, soyabean etc. and must be capable of placing the seed in continuous flow at constant depth with or without covering them with soil where optimum soil temperature and moisture are available for germination. Seed drill gives higher crop yield as compared to broadcast sown seeds or others seeding method. Also zero-till seed-cum-fertilizer drill is specially designed for placement of seeds and fertilizer into the cultivated field which saves time and cost of operation with increase in yield as compared to conventional method [4]. The use of seed drills also helps the seeds in rows which facilitates intercultural operation. Seed drills or seed-cum-fertilizer drills (bullock drawn or tractor drawn) facilitate line sowing and proper application of seed and fertilizer in the field. Thus there is a saving of 10 to 15 per cent inputs, 65 per cent of labour and operating time and 45 per cent cost of operation as compared to conventional method. The furrow opener of sowing device is the final modifier of soil environment in seed bed. The furrow openers along with boot affect the amount of soil covering which largely determines the seed germination and resultant plant development. Hence, it is one of the most important components of a seed drill. Among different type of furrow openers used in seed drills, shoe type furrow opener is one of the commonly used furrow opener.

Justification and Scope of the study

The role played by seeding machinery is increasing the crop yield keeping all other inputs the same has been well recognized throughout the world. If seed is not placed at proper depth in moist soil, it will adversely affect the germination. Seed-cum-fertilizer drill place seed and fertilizer at resultants in better utilization of plant nutrients. It has been found that with the use of seed drill the yield has been increased by 10 to 20 per cent [5]. The various researchers have shown that shoe type furrow opener gives better performance than other furrow openers in relation to penetration ability, non clogging of seed and fertilizer in boots. They are simple in design and because of simple construction, cheapness and sharpening edge they are widely used in seed drills for opening the furrow for placement of seed and fertilizer. They give more compaction of the furrow bottom and less seed scatter than other furrow openers like shovel and hoe openers [6].

The objectives of this experiment are

- To study the effects of selected furrow openers on soil disruption for seed drills in Udaipur region.
- To study the effect of speed of operation on soil disruption of selected furrow openers for seed drills in Udaipur region

Materials and methods

The present study was planned to observe the effect of speed of operation and types of furrow openers on soil disruption in sandy loam sand.

Selection of experimental parameters

Various parameters considered in the present study are discussed in this section.

Figure 1: *Seed drill used for experiment*

Type of furrow openers

a) Shoe type furrow opener

In the region, no standard shoe type furrow openers are used in both animal and tractor drawn seed drills. Seed drills of the region are fitted with the different sizes of shoe type furrow openers having origin from National Agro Industries and Sherpur Agro Industries, Ludhiana(Punjab).

Figure 2: *Shoe Type Furrow Opener*

b) Shovel type furrow opener

Figure 3: *Shovel type furrow opener*

Speed of operation

Speed of operation was kept 4km/h, 5km/h and 6 km/h.

Depth of operation

Sowing of various sizes of seeds is usually done at depth of about 0.05 m in the region. Keeping this in view experiments were conducted at this depth.

Table 1: Various parameters considered in the study

S. No.	Parameters	Levels	Particulars
1	**Furrow Opener Parameter**		
	Furrow Opener Type	2	Shoe and shovel type
2	**System Parameter**		
	Speed (m/s)	3	4 , 5 and 6 km/h
	Depth of Operation (cm)	1	5 cm
3	**Soil Parameter**		
	Soil Type	1	Sandy loam soil
	Moisture Content (db)	1	11.1%
	Bulk Density (gm/cc)	1	1.66

Parameters measured during the experiment

Sandy loam soil having bulk density 1.66 gm/cc and moisture content 11.1 % was used in the experiment.

Soil moisture content

Soil moisture content was determined by standard oven dry method. The soil moisture content was calculated by using the following formula:

$$\text{Moisture content (\% db)} = \frac{W_3 - W_2}{W_2 - W_1} \times 100$$

Where, W_1 = Weight of empty moisture box, g

W_2 = Weight of dry soil and moisture box, g

W_3 = Weight of wet soil and moisture box, g

Bulk density

It is the mass of soil of a unit volume. It is measured using core cutter method and was calculated using the following formula:

$$\text{Bulk Density (g/cc)} = \frac{M}{V}$$

Where, M = Mass of soil in core cutter, g

V = Volume of core cutter, cm^3

Soil Disruption

Sowing implement disrupt the soil profile. Soil profile is a measure of effectiveness of tillage implement. It can be surface soil disturbance or spoil which is a measurement of the amount of soil displaced above the original soil surface by the seeding process and subsurface soil disruption which is the area that is disrupted below the soil surface or trench area [7]. The parameters of the soil disruption include the parameters given in Figure 5.

Soil disruption was measured with the help of soil profilometer (Figure 4). The profilometer was fixed across the trench. The main scale was adjusted with the knobs and spirit level to keep it horizontally leveled. With the help of plumb bob the vertical depth or height of the soil surface was determined at every 1 cm horizontal distance on main scale. Replicated observations of soil disruption were recorded for both furrow openers. After completion of the surface disruption measurement the profilometer was kept installed and the manipulated soil mass was removed from the trench below the profilometer with hand without disturbing the instrument. Care was taken to ensure that only soil loosened by sowing implement was removed. The cross sectional area of spoil and trench were calculated.

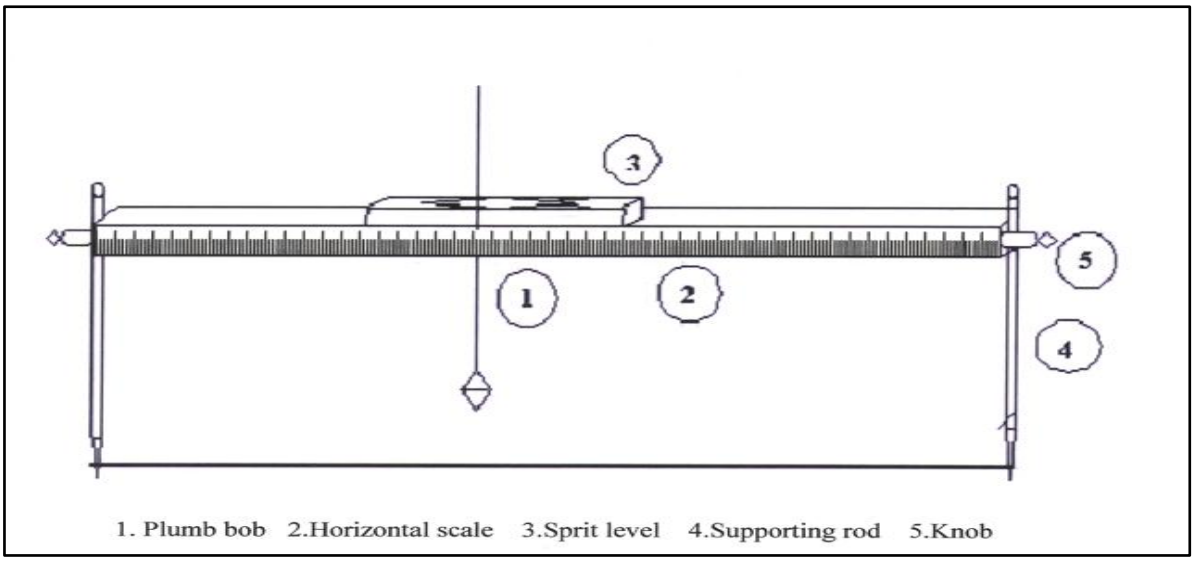

Figure 4: *Schematic view of soil Profilometer for measurement of soil disruption*

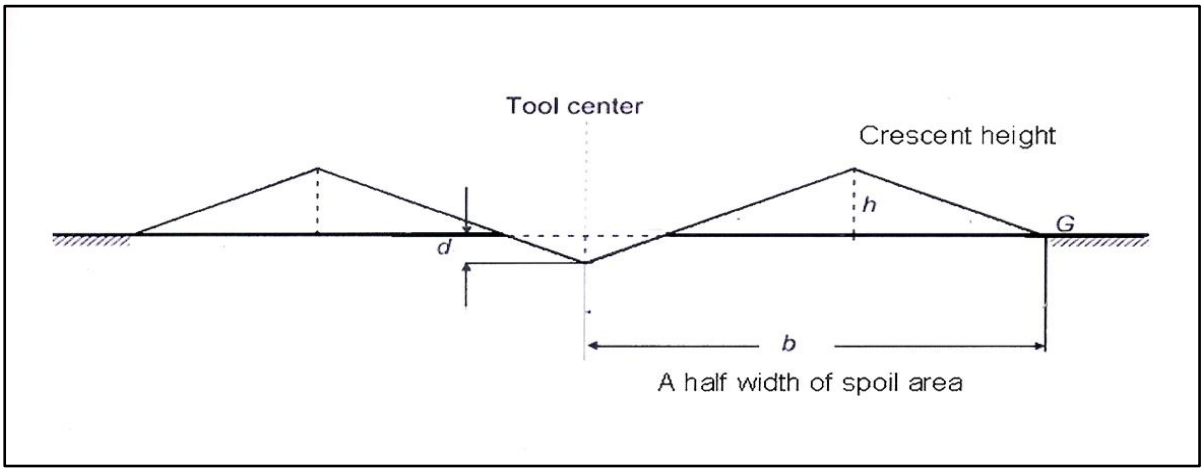

Figure 5: *Measurement of soil disruption*

Results and Discussion

The present study was conducted to observe the effect of speed of operation (4 km/h, 5 km/h and 6 km/h) of shoe and shovel type furrow openers used for tractor drawn seed drill in sandy loam soil on soil disruption. The experiments were conducted at average soil moisture content of 11.1 per cent dry basis at instructional Farm, CTAE, UDAIPUR.

The results obtained during the experiments have been extensively discussed in this chapter under following headings:

1) Effects of shoe and shovel type furrow openers on soil disruption for seed drills.

2) Effect of speed of operation on soil disruption of shoe and shovel furrow openers.

Effects of shoe and shovel type furrow openers on soil disruption

In this study the soil disruption is a measurement of the amount of soil displaced above the original soil surface (spoil) and below ground level (trench) by the tillage process [7].

Figure 6 and 7 shows spoil and trench profiles created by shoe and shovel type furrow opener at different speeds. At lower speed of operation shovel type furrow opener (23 cm) gives 27.78 percent more furrow width than shoe type furrow opener (18cm).

At speed of operation of 5 km/h shovel type furrow opener gives 23.07 percent more furrow width than shoe type furrow opener and at speed of operation of 5 km/h shovel type furrow opener gives 19.40 percent more furrow width than shoe type furrow opener.

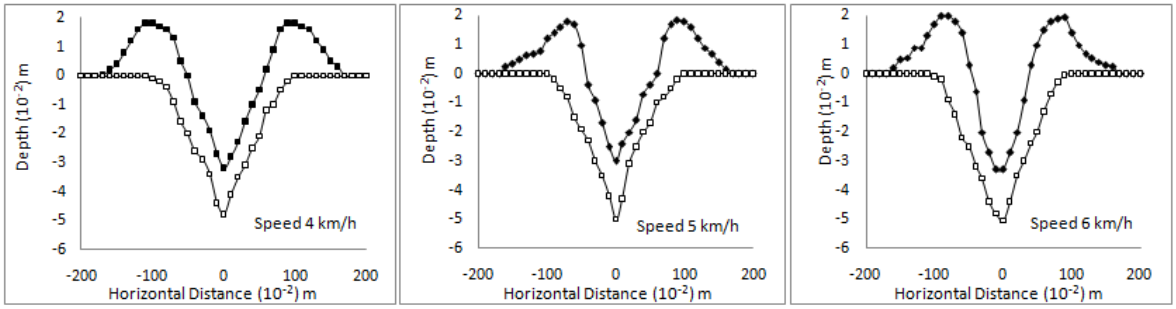

Figure 6: *Spoil and trench profile at different speed of operations for Shovel type furrow opener*

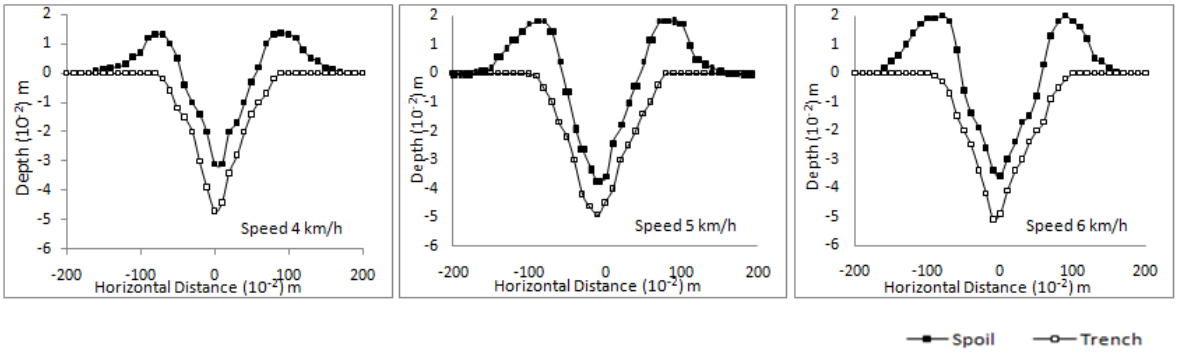

Figure 7: *Spoil and trench profile at different speed of operations for Shoe type furrow opener*

Figure 8 show that at speed of operation of 4 km/h, crescent height is 5.91 per cent more for shoe type furrow opener than shovel type furrow opener. Similar trend of increasing crescent height was observed at all speed of operation.

Effects of speed of operation on soil profile

The spoil and trench profiles created by shoe and shovel type furrow openers at different speed of operations are presented through figure 8. The figures shows that spoil furrow width and spoil furrow depth increases with increase in speed of operation for both furrow openers. This may be attributed to increase in speed of operation of the furrow openers which resulted in tossing of more soil and redistributing it in wider length outside the trench. Similar findings are also reported by [8].

Table 2: Test results at different speed of operations for shoe and shovel type furrow openers

Furrow opener	Depth, m	Speed, km/h	Spoil area, 10^{-3} m^2	Trench area, 10^{-3} m^2	Crescent height, m
Shoe type	**0.05**	4	3.251	3.300	0.0170
		5	3.707	4.125	0.0184
		6	4.285	4.324	0.0193
Shovel type	**0.05**	4	4.210	4.320	0.0181
		5	4.680	4.743	0.0198
		6	5.514	5.143	0.0202

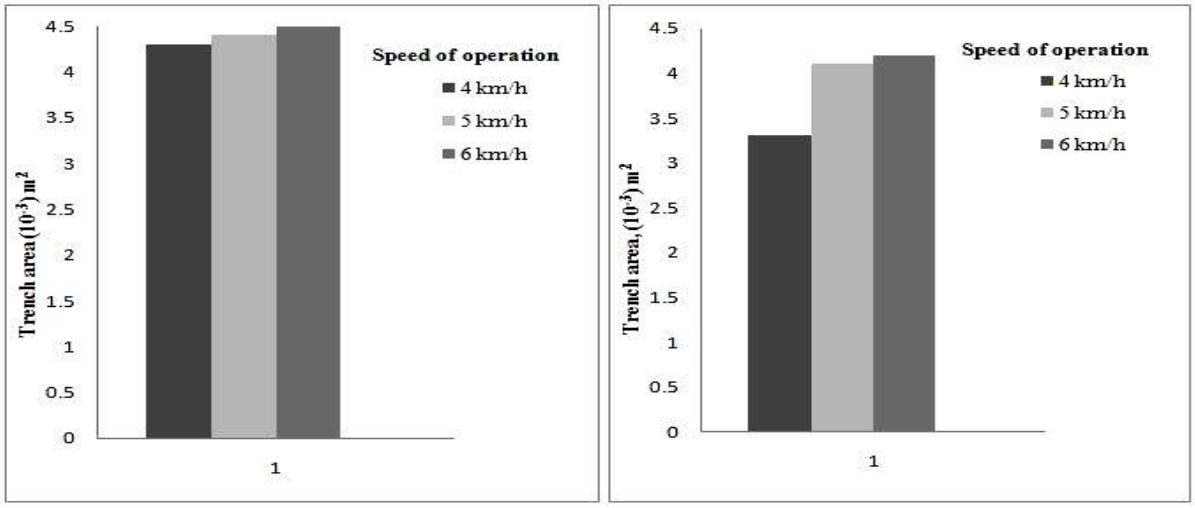

Figure 8 *Effect of speed of operation on trench area*

Figure 6 to 7 shows that at speed of operation of 4 km/h, spoil area created by shovel type furrow opener (4.210×10^{-3} m^2) is 29.49 percent more than shoe type furrow opener (3.251×10^{-3} m^2).

As speed of operation increases upto 5 km/h spoil area for shoe type furrow opener increases by 14.03 percent and for shovel type furrow opener it increase by 11.16 percent. Similar trend of increasing spoil area was observed at all speed of operation.

Figure 8 shows that trench area increased with increase in speed of operation for both the furrow openers. Shovel resulted in more trench area than shoe at all speed of operation. This may be due to the wide cross section of shovel that disturbed a larger zone of soil than shoe.

Summary and Conclusions

Sowing is one of the most important farm operations. Seed drill is used for sowing seeds of various sizes viz. wheat, gram, soyabean etc. and must be capable of placing the seed in continuous flow at constant depth with or without covering them with soil where optimum soil temperature and moisture are available for germination. Seed drill gives higher crop yield as compared to broadcast sown seeds or others seeding method. The furrow openers along with boot affect the amount of soil covering which largely determines the seed germination and resultant plant development. The furrow opener of sowing device is the final modifier of soil environment in seed bed. Hence, it is one of the most important components of a seed drill. Among different type of furrow openers used in seed drills, shoe type furrow opener is one of the commonly used furrow opener. The various researchers have shown that shoe type furrow opener gives better performance than other furrow openers in relation to penetration ability, non clogging of seed and fertilizer in boots. They are simple in design and because of simple construction, cheapness and sharpening edge they are widely used in seed drills for opening the furrow for placement of seed and fertilizer. They give more compaction of the furrow bottom and less seed scatter than other furrow openers like shovel and hoe openers.

Following conclusions found in the study

- Furrow width, Crescent height and trench and spoil area increases with increase in speed of operation for both furrow openers.
- Trench and Spoil area was more in shovel type furrow opener than shoe type furrow opener.

Properties of the experimental soil

Soil type	Sandy loam soil
Mechanical Composition:	
Bulk density	1.66 g/cc
Moisture content	11.1 % (d.b)

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