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Research Article

COMPARATIVE ANALYSIS OF SECONDARY TILLAGE TOOLS IN VERTISOL

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Abstract- Tillage is the basic operation in agriculture and its energy represents a considerable portion of the total energy utilized in crop production. Performance evaluation of different types of tillage tools was studied by using a tool carrier in vertisol condition. The tools include shallow sweep, right side sweep, left side sweep and heavy duty sweep. split plot design was used to study the performance evaluation of different types of tillage tools. Each tool was attached to the tool carrier and put in lower hitch position of the tractor. For maintain the proper depth of operation, 200 kg weight was kept in the center of the tool carrier. Tool carrier was also operated at fixed speed (2.12 km/h). It was found that, for all the tillage tools unit draft was inversely proportional to the depth of operation. Minimum unit draft was observed for heavy duty sweep i.e. 14.35 N/cm^2 followed by shallow sweep, right side sweep, left side sweep (i.e. 15.43, 25.45, and 23.58 N/cm^2). Statistical analysis reveals that tool shape had significantly effect on the unit draft. From the results, it can be concluded that heavy-duty sweep showed maximum performance index i.e. 70%. Also heavy duty was found superior over other tools, although shallow sweep gave satisfactory results in respect to field capacity and energy requirement.

Keywords- Tillage tool, Moisture content, Unit draft, Performance index, Tool carrier

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Introduction

The growth of agricultural mechanization has been rapid during last four decades. The mechanization of Indian agriculture has played an important role in increasing agricultural production, productivity and profitability by timely farm operations. Tillage being the maximum energy consuming operation in crop production has been a field of great interest and work for agricultural engineers. Reduced draft requirement and versatility in manipulating the soil to obtain a desired seed bed are the two main goals of using the tools Ref [1]. Objective of manipulation of the soil by tillage tools is to produce soil conditions and environment favorable to crop growth by changing bulk density, soil-aggregate, size distribution and other characteristics of the soil. The study on tillage tools has been conducted to generate data that will aid in more efficient use of available tillage tools and will also provide a basis for the design and development of new equipment to do the necessary tillage operations most economical. A thorough study of soil parameters at different stages and evaluation of their effect on performance of commonly used tools is therefore necessary Ref [2]. This will help in obtaining the best workable soil conditions and type of operating tillage tools at minimum draft. Although one of the major objectives of tillage is to provide the optimum environment condition for plant growth, the desired soil conditions cannot be qualitatively specified, or identified. The objective of this study was to assess the performance of different tillage tools for best workable soil conditions.

Material and Methods

At present, the farmers of a particular region are using the traditional tillage tools and follows tillage practices which are different from the other region and that to for vertisol. Similarly, local manufacturers are fabricating the tillage tools as per the traditional practices being adopted by the farmers of a particular region only for vertisol. Now the systematic study has been not conducted in actual field conditions under vertisol for the selection of best shape of cultivator tool. Therefore, has been made for the same in the machinery and soil physical parameters points of view. The present study was made by considering above factors more prominently.

Procedure

For testing the tillage tools a soil moisture content range 16-25% (db, dry weight basis) was obtained and for the purpose, experimental plots were irrigated and allowed to dry up to the desired range of moisture content i.e. 16-25 %(db). The operating speed of the tillage tools was maintained at 2.12 km/h for all tools. After the completion of fabrication, the tool-carrier with tillage tools was operated in the field and to evaluate the ease of operation and functional performance of tillage tools and tool carrier. Finally, the field was prepared to test the tillage tools and observation on the physical of the soil such as moisture content, cone index and bulk density were taken before the testing of tillage tools taken under study. After running-in, the tillage tools and the tool-carrier were ready for the test. The study and end part of each plot was made to calculate the speed of operation. The stop watch was used to record the time to cover the test distance of 30m. A digital type dynamometer was fixed horizontally between the tractor hitch point and the tool-carrier. The digital dynamometer directly gives the value of draft in kgf. The detail of tool-carrier is given in [Fig-2] and [Fig-3]. The tool-carrier with dead weight of 200kg was pulled by the tractor, when tractor and tool-carrier passed the first pole, the readings of dynamometer was recorded, and the time required to traverse 30 m length was recorded, for the calculation of speed of operation. The throttle position and selection of gear of tractor was decided to obtain fixed test speeds before the actual start of the tests and recording of observation. One of the tillage tools was attached to the tool-carrier tyne. After that the tool-carrier attached to the tractor was allowed to run in the field. When tractor and tool-carrier passed the first pole, the readings of dynamometer at different intervals were recorded and the time required to traverse 30m length was recorded for the calculation of speed of operation.

The furrow was cleaned at five places to take the depth and width of furrow with the help of steel scales. The soil samples were collected at different places for the sieve analysis. The sieve analysis of the soil samples was done to find out the mean mass diameter of the soil after each test. The results all the four tools were analyzed statistically and the performance of the tools was determined.

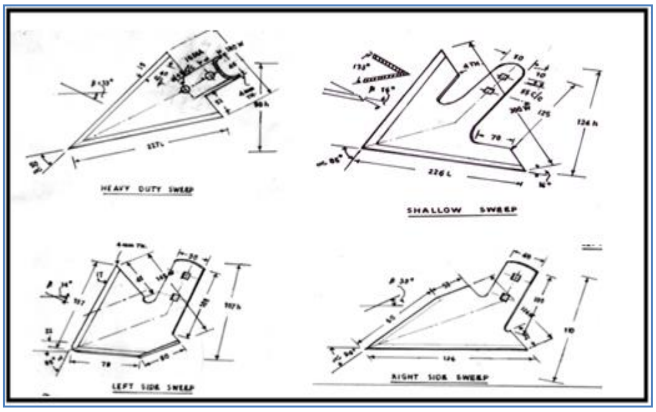


Fig-1 Schematic diagram of reversible shovel and shallow sweep used in experiment

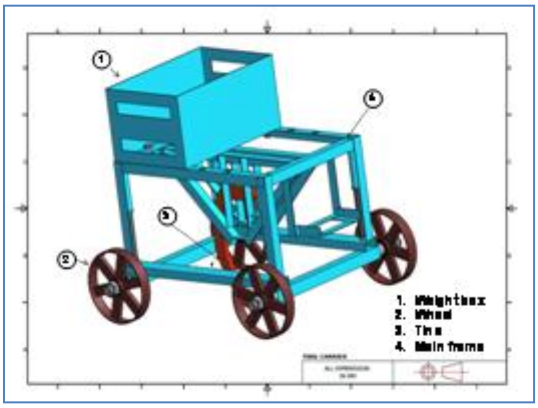


Fig-2 Pictorial view of tool carrier

Fig-3 Tool carrier attached with the tractor

Result and Discussion

Field capacity

The field capacity of different shapes of sweep at 16% of moisture content of soil shown in [Fig- 4(a)]. the maximum field capacity was found for shallow sweep (T_1) i.e. 0.043 ha/h and minimum field capacity for right side sweep (T_2) i.e. 0.024 ha/h. Whereas for left side sweep (T_3) and heavy duty sweep (T_4) it was found to be 0.030 and 0.037 ha/h at 2.10km/h speed respectively at 16% moisture content of soil.

Draft requirement

The maximum draft was found to be 3290.27N with T_1 and minimum was i.e. 2793.89N in T_2 shown in [Fig-4(b)]. Whereas for T_3 and T_4 it was found to be 2893.95 and 3153.03N. T_1 required higher draft because it penetrates more as compared to other tools. On the basis of the results obtained it can be concluded that the secondary tillage tools can also be used effectively for primary tillage operation even if bullocks are used as the power source Ref [3].

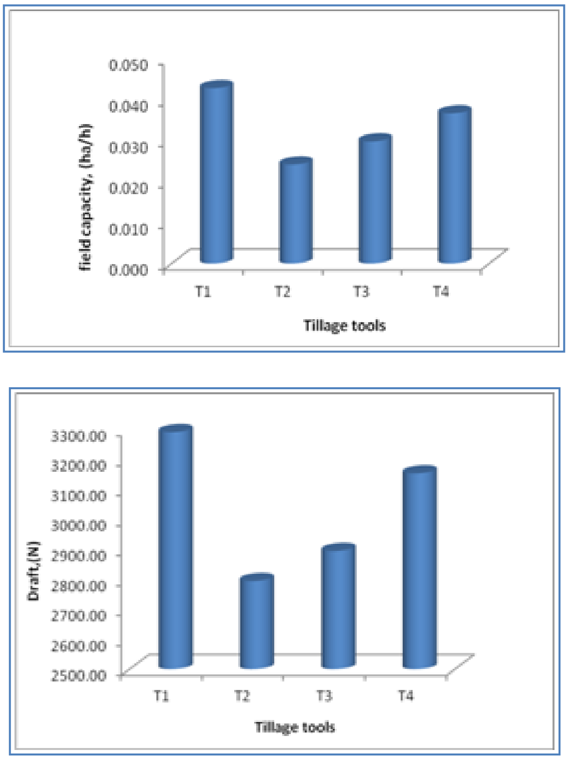


Fig-4 a)Field capacity and b) Draft of shallow sweep, right side sweep, left side sweep and heavy duty sweep

Unit draft

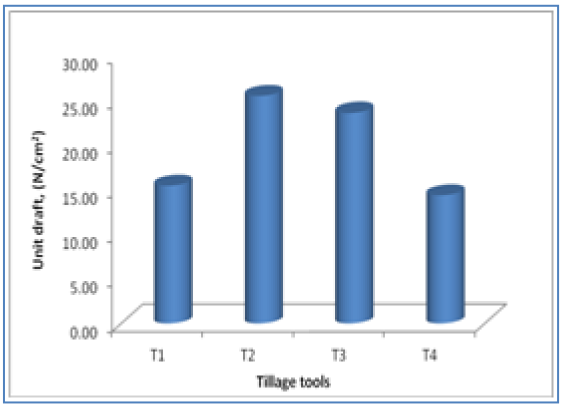
[Fig-5(a)] shows the unit draft of different types of sweeps at 16% (db) moisture content. The data indicates that the unit draft is maximum i.e. 25.45N/cm^2 and minimum with T_4 i.e. 14.35N/cm. whereas for T_1 and T_3 i.e. 15.43 and 23.59 N/cm^2 respectively. The variation was found to be minimum i.e. 7.5, 77.35, 64.39% for T_1, T_2 and T_3 respectively. The variation in the unit draft obtained is due to the shape of tool, depth and speed also Ref [3].

Power requirement

Power requirement for operating different tools are directly proportional to its depth of operation. The maximum power requirement was found to be in the case of T_1 i.e. 1.93kW. Whereas for T_2 (1.64kW), T_3 (1.70kW) and T_4 (i.e. 1.85kW) shown in [Fig-5(b)]. The minimum power required was obtained in the T_2 i.e. 1.64kW. The difference between maximum and minimum power requirement for all the tillage tools was only 0.24kW. It indicates that power requirement is directly proportional to the depth of operation of tillage tool. The minimum power requirement was obtained with T_2 and this may be due to its shape i.e. it's with narrow share. This resulted in minimum draft and field capacity as compare to other tools.

Energy requirement

[Fig-6(a)] shows the variation in energy requirement for different type of sweeps at 16% (db) moisture content of soil. T_2 consumes maximum energy i.e. 67.66 kWh/ha. It was also observed that minimum variation in the energy requirement was in the T_1 i.e. 45.38 kWh/ha, whereas T_3 and T_4 had approximately same value. For all the tools the variation in energy requirement was indirectly proportional to the width of tool. The maximum energy requirement was found with T_2 because right side sweep had minimum width of 12.7cm.



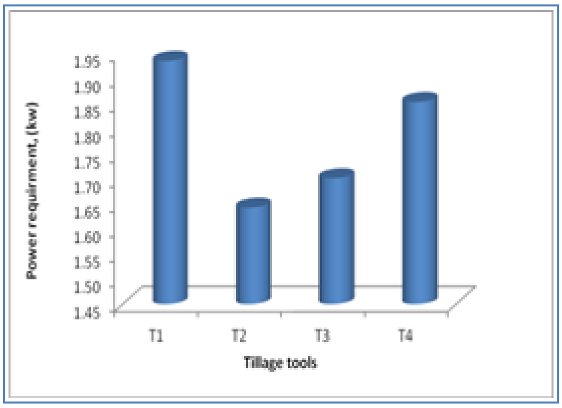


Fig-5 a) Unit draft and b) Power requirement of shallow sweep, right side sweep, left side sweep and heavy duty sweep

Table-1 *Specification reversible shovel and shallow sweep*

S. No.	Name of tools	Length (mm)	Width (mm)	Height (mm)	Loading angle (degree)	Setting angle (degree)
1.	Shallow sweep (T_1)	180	300	110	16	42.5
2.	Right side sweep (T_2)	190	130	110	35	47
3.	Left side sweep (T_3)	180	150	120	14	42.5
4.	Heavy duty sweep (T_4)	210	180	80	13	26.5

Performance index

Among four tillage tools the maximum value of performance index was found to be 70.02% for treatment T_4 and minimum was 36.30% with treatment T_2. The results revealed those treatments T_2 and T_3 showed same value i.e. 36.52 and 38.30 %as shown in [Fig-6(b)]. For all the tools, the variation in performance index was indirectly proportional to the unit draft.

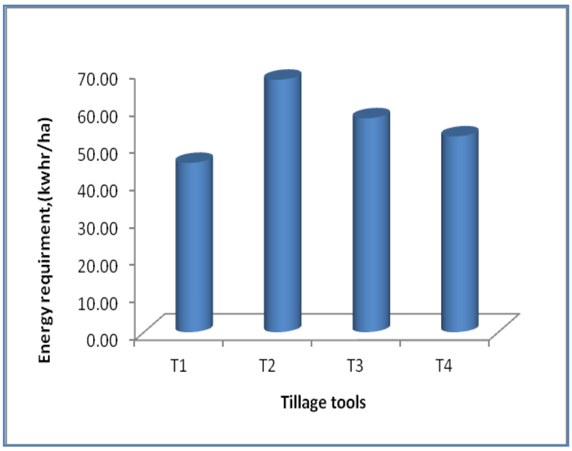
Performance evaluation of different type of sweeps on the basis of soil physical properties in vertisol condition

Bulk density

The bulk density of soil was reduced as compared to no till condition i.e. 1.97g/cc. The [Fig-7(a)] indicates that the T_3 resulted into maximum bulk density i.e. 1.01g/cc and minimum for T_4 i.e. 0.84g/cc. The may be due to shape and cutting surface of heavy duty sweep. The volume of soil handled by the heavy-duty sweep was also more and time for contacting the soil with metal tools was more resulted in to low bulk density value. But this is not true all the time. Handling more volume of soil also enhance the draft. The result are also reported by the other researcher Ref [4] and Ref [5].

Soil pulverization

Results reveal that mean mass diameter of soil was found to be maximum with T_2 i.e. 11.16 mm and minimum was 10.15 mm for treatment T_1. The result reveals that the treatments T_2 and T_3 had approximately same value i.e. 11.16 and 11.08 mm. It was also found out that shallow sweep provided fine tilth under the normal soil condition. This may be due to the reason that shallow sweep with the narrow point cuts the soil and which is also true for the heavy duty sweep. Whereas in case of the right and left side sweep, the soil was riding over the wing resulted into more mean mass diameter that is shown in [Fig-7(b)].



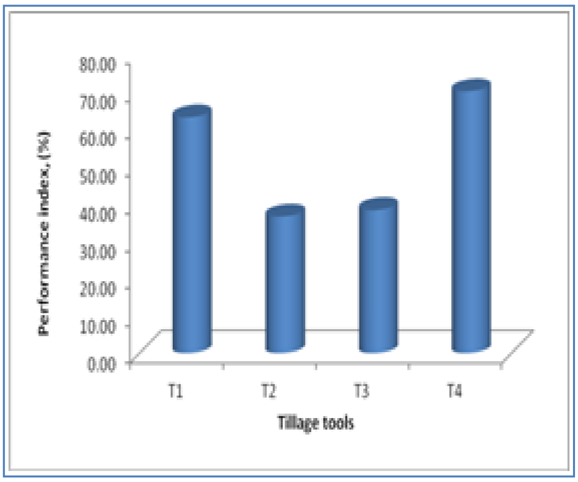
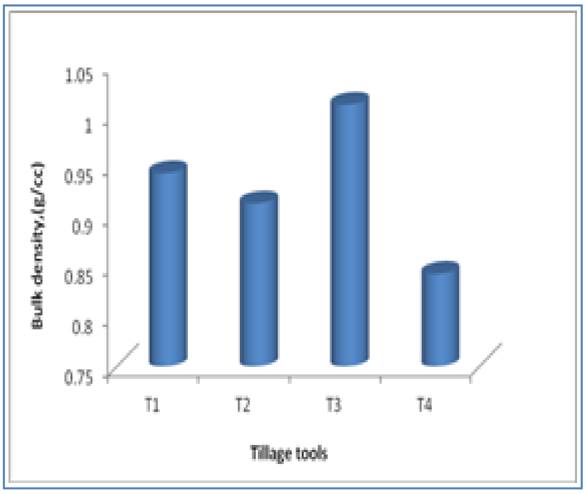


Fig-6 a)Energy requirement and b) Performance index of shallow sweep, right side sweep, left side sweep and heavy duty sweep



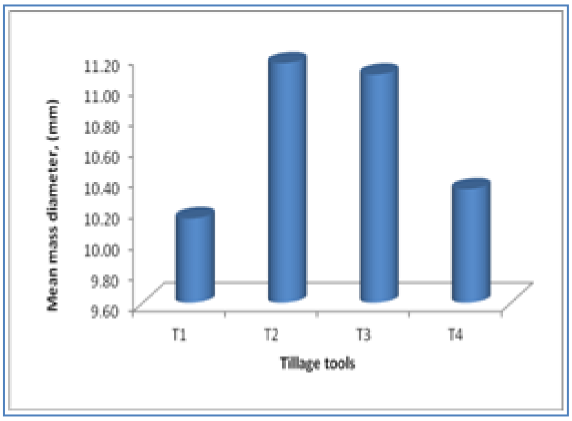


Fig-7 a)Bulk density and b) Mean mass diameter of shallow sweep, right side sweep, left side sweep and heavy duty sweep.

Conclusions

From the result, it can be concluded that the value of draft increases with the increased depth of operation. The maximum draft was found to be 3290.27 N with the shallow sweep (T_1) and minimum was i.e. 2793.89 N with the right side sweep (T_2). It was also found out that for all the tillage tools unit draft is inversely proportional to the depth of operation. Minimum unit draft was observed for heavy duty sweep i.e. 14.35 N/cm^2 followed by shallow sweep, right side sweep, left side sweep (i.e. 15.43, 25.45, and 23.58 N/cm^2). Statistical analysis reveals that tool shape had significantly effect on the unit draft. Heavy-duty sweep was found superior over other tools, however shallow sweep gave satisfactory results. The power requirement was minimum for right side sweep (T_2) i.e. 1.64 kW due to its shape i.e. narrow share followed by shallow sweep, left side sweep and heavy duty sweep. The mean mass diameter of the clods increased with respect to depth of operation. From the results, it can be concluded that heavy duty gave maximum performance index i.e. 70%. The effect of energy requirement for different types of sweeps at 16% (db) moisture content was higher as compared to the energy requirement at other two levels of moisture content i.e. 20% and 25 %. Right side sweep (T_2) consumed maximum energy i.e. 67.66 kWh/ha, whereas energy requirement was minimum for shallow sweep (T_1) i.e. 45.38 kWh/ha.

Author Contribution

My esteemed guide Prof. R.K. Dubey and Dr. Atul Kumar Shrivastava give valuable guidance, constructive criticism and appreciation, valuable suggestion and constant critical support throughout the period of my study. Senior Abhay Kumar Sinha give me sincere help during the preparation of the manuscript.

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Conflict of Interest: None declared

References

[1] Ahiwar A., Gupta S. and Mishra V. (2012) Fabrication and Testing of the Tools. B. Tech. Thesis, JNKVV, Jabalpur: 34p.
[2] Kumar S. (2002) Development of primary tillage tool for tractor drawn cultivator. M. Tech. thesis, Collage of Agricultural engineering, JNKVV, Jabalpur.
[3] Jogdand S.V. (1987) Performance evolution of tillage tools under controlled conditions. M. Tech. thesis, Collage of Agricultural engineering, JNKVV, Jabalpur.
[4] Panwar J.B. and Siemens J.C. (1972b) *Trans. of the ASAE,* 15(3), 423.
[5] Aikins S.H.M. and Afuakwa J.J. (2012) *Agriculture and Biology Journal of North America*.