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Performance evaluation of cultivator and its influence on various soil physical properties

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Abstract
Tillage is the agricultural preparation of soil by mechanical agitation of various types, such as digging, stirring, and overturning. In agriculture the main objective of tillage is to provide optimum condition for plant growth. The operation was carried out by using cultivator at varying depth of 0-5cm, 5-10cm and 10-15cm with varying speed of 8,12 and 16km/hr.The research study revealed that the field capacity was influenced by working depth and plowing speed and bulk density and moisture content. The main purpose for performing this research was to estimate the effective speed and depth of tillage performed by the cultivator for better soil tilth.

Keywords: Cultivator, soil physical properties, field characteristics, different working depth and speed

1. Introduction
Tillage practices facilitate water penetration into the soil and enhance the quantity of water retained for the longer use by crop. Sub soil tillage improves water infiltration; decreases bulk density, penetration resistance and increase water holding capacity as compared to no-tillage treatments. Inappropriate tillage causes subsoil compaction. Soil compaction reduces the water and nutrient use efficiencies of crops.

1.1 Tillage Effect on Soil Properties
Tillage affects soil physical, chemical and biological properties. Important soil physical properties such as bulk density, penetration resistance, water infiltration, hydraulic conductivity and soil compaction are affected by tillage (Hamza and Anderson, 2005).
The soil type used for the proposed topic is sandy to clayey loam which is the soil type of U.P. state.
The combination of organic matter, air and water determine the soil's property- structural, porosity, chemistry and color. Soils that are the mixture of sand, silt and clay are called loams.
The soil properties was slightly more favorable to plant growth, especially in a top layer of 24cm depth. The implement used for proposed topic is cultivator. It is used to further to loosen the previously ploughed and to destroy weeds that germinate after ploughing. The number of tynes ranging from 7 to 13 for depth of 15cm to 35 cm of the soil. The indirect economic benefits of tillage with cultivator lie in preserving the soil structure and in creating and maintaining the favorable state of the soil.
The current research work deals with the utilization of cultivator on a farm field to examine and to carry evaluation pertaining to its performance and its effect on the soil physical characteristics. Several researches were previously done on rotavator, disc harrow, disc plough and other secondary implements regarding the same agenda mentioned. The present research activity is wholly concerned with cultivator of which provides a vast exploration on its field of study. The investigation can prove to be prolitic for the research farmers so that they can access it in order to enhance the efficiency, economy and at the some-time improve the productivity and profitability. The scructing of the work involves the usage of cultivator at varying speed and depth. So that any sort of soil can be cultivated and helps in providing a measure to adapt and manipulate the different soil condition prevailing across the conditions.

2. Materials and Methods
2.1 Field Preparation
Field research work was carried out in sandy loamy soil during winter season at SHUATS University Allahabad. The plot size of work was 6m x 28m and which was divided into sub-plot size of 2m x 28m at 0.5m spacing between them. There were total three plot alotted for the mentioned research work. Sonalika on (35 Hp) diesel engine tractor was used to operate the implement in field.

The performance parameters studied were wheel slippage, field capacity, effective field capacity, theoretical field capacity and soil physical properties like- soil moisture content, bulk density and porosity

2.2 Field Procedure
Leading with field procedure the marked fields of tractor were tilled with their cultivator according to procedure, field (A) of 375m^2 x 3 plots were first plowed by cultivator at speed 8km/hr and depth 5cm, 10cm and 15cm and required parameters were obtained, Similarly the Field B was treated with cultivator at speed 12km/hr and Field C was first treated with cultivator at speed 16km/hr the same procedure,and all parameters were obtained the parameters of soil properties and implement factors of three fields were compared.

Table 1: Speciffications

No. of tynes	9
Tynes size	(2×42) cm^2
Tynes Spacing	23 cm
Frame Size	40×10 mm^2
Length of frame	2200 mm
Shovel Type	Reversible shovel
Width of shovel	65mm
Thickness of shovel	4mm
Angle of cut	15- 20^o
Tractor Compatibility	35 HP

3. Results and Discussion
3.1 Effect on Soil Physical Properties
3.1.1 Soil Moisture Content
The moisture percent level after recommended tillage practices in specific fields the moisture percentage increases at same depths (5, 10, and 15 cm). The moisture content of the soil before and after tillage operation by using cultivator significantly increases with increasing depth and show significant chances with varying speeds this is due to the fact that at surface level evapotranspiration takes place faster and through infiltration of water upto 15cm the moisture is trapped inside the pores of the soil.

3.1.2 Bulk Density (g/cm^3)
Correspondingly the mean average of soil bulk density before and after tillage operation for both fields with replications was found slightly decreased from 1.67 g/cm3 to 1.32 g/cm3, for Field A at speed 8 km/hr, Similarly, soil bulk density of field B at varying depth was decreased from 1.52 g/cm3 to 1.47 g/cm3, at speed 12 km/hr. and of field C, it was decreased from 1.55 g/cm3 to 1.52 g/cm3, at speed 16 km/hr. The lowest bulk density obtained after tillage is speed 8 km/hr.

3.1.3 Porosity
Porosity of the soil is inversely proportional to the bulk density. Since, bulk density of the soil increases with increasing depth and speed. Therefore, the porosity of the soil decreases with increasing depth. Porosity of the soil before tillage is lesser than porosity of soil after tillage using cultivator. Porosity of the soil shows significant changes with varying speed and depth. The highest porosity obtained after tillage using cultivator is speed at 8 km/hr

Table 2: Effect of depth and speed on soil physical properties before and after tillage

T	Speed (km/hr)	Depth (cms)	Soil Moisture Content (%)		Bulk Density (g/cm^3)		Porosity (%)	
			Before	After	Before	after	Before	After
T1	8	0-5	11.25	11.78	1.68	1.32	36.2	49.9
T2		5-10	13.91	14.51	1.74	1.36	33.9	48.3
T3		10-15	14.72	16.21	1.6	1.41	39.2	46.4
T4	12	0-5	10.74	12.64	1.53	1.48	41.9	43.8
T5		5-10	12.70	15.18	1.50	1.45	43	44.9
T6		10-15	13.89	16.32	1.53	1.47	41.9	44.2
T7	16	0-5	10.74	12.27	1.57	1.52	40.4	42.3
T8		5-10	12.34	15.09	1.55	1.52	41.1	42.3
T9		10-15	14.30	14.27	1.53	1.52	41.9	42.3

3.2 Effect on Field characteristics
3.2.1 Wheel Slippage
The total numbers of revolutions taken for calculating wheel slippage is 10.The average wheel slippage for all treatments after making calculations was found to be 14.16% for cultivator at 8 km/hr, 14.14 % at depth 12 km/hr, and Similarly wheel slippage at depth 16km/hr was 14.52. The wheel slippage of tractor is mainly associated with the depth and width of implement. Since non ploughed land has more bulk density and soil strength on increasing depth.

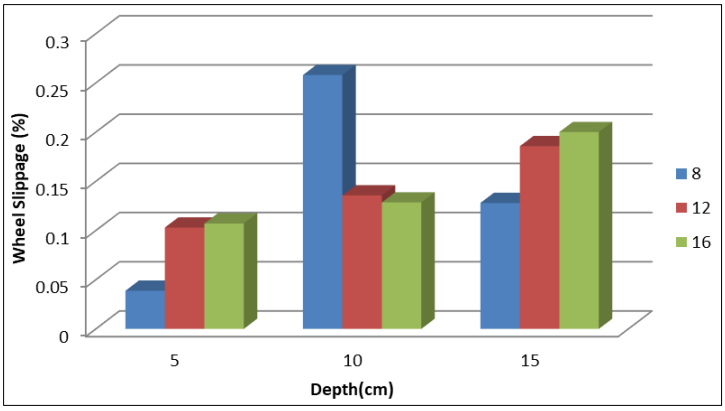

Fig 1: Effect of depth and speed on wheel slippage

3.2.2 Effective Field Capacity

The study shows effective field capacity produced by cultivator was greater at speed 16km/hr and the calculated values depicts that the cultivator has average EFC of 0.0502 ha/hr at speed 8km/hr, 0.0576 km/hr at speed 12km/hr and was 0.078 ha/hr at speed 16km/hr. Similarly Panwar and Siemens (1972) studied the effect of density and moisture content on the shear strength and energy for soil failure. The shear strength of soils increased with an increase in the moisture content.

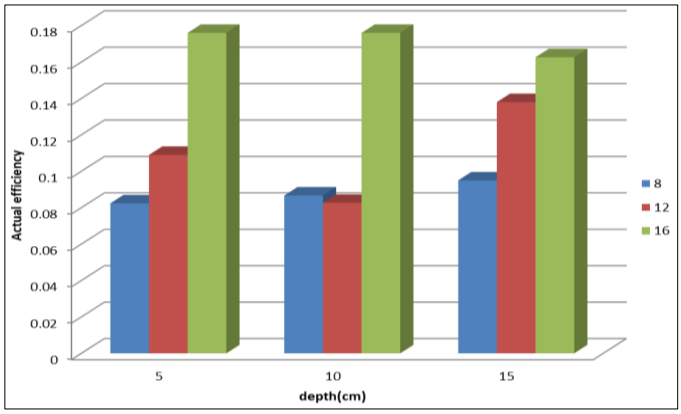

Fig 2: Effect of depth and speed on EFC

3.2.3 Theoritical Field Capa

Figure3shows that Theoretical field capacity of the field was 0.088hac/hr at speed 8km/hr, 0.109 hac/hrat speed 12km/hr and 0.1715km/hr at speed 16km/hr. The TFC increases with increasing in depth. Since the actual force and soil strength is exerted on the equipment in the field therefore TFC increases compare with EFC.

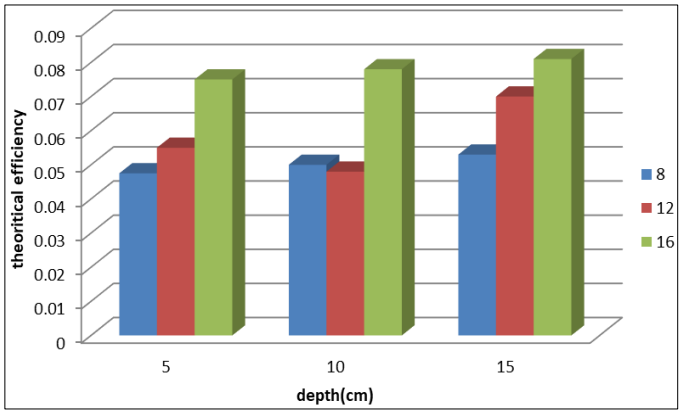

Fig 3: Effect of depth and speed on TFC

3.2.4 Field Capacity

Field capacity is one of the major factors in determining the performance of all tillage machines. Field capacity of the machine is the rate of performing work per unit time. The data related to field capacity by cultivator is in Fig 3. The result shows that the field capacity produced by cultivator was greater at speed 16km/hr and the calculated values depicts that the cultivator has average field capacity of 0.5699 ha/hr at speed 8km/hr, 0.5138 km/hr at speed 12km/hr and was 0.4557 ha/hr at speed 16km/hr.

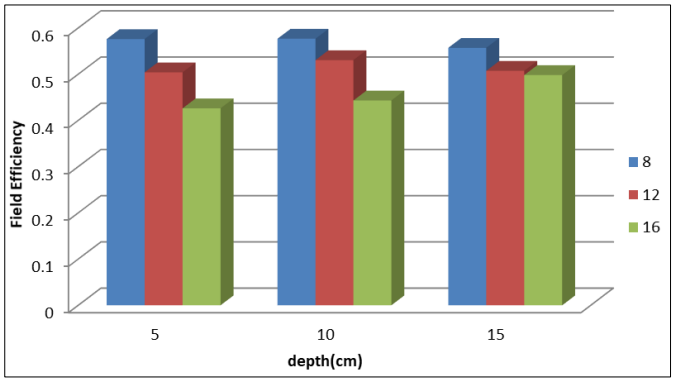

Fig 4: Effect of depth and speed on FC

4. Conclusion

On the basis of present study that field characteristics and soil physical properties required for better soil tilth after tillage increases with increasing depth and speed. This treatment improved soil structure, which provided suitable environment for plant growth. Plowing depth has significant changes in moisture content, wheel slippage, porosity and bulk density. Soil bulk density decreased with increasing depth of cut by cultivator and increases with increasing speed. Porosity increases after tillage at speed 8km/hr and decreases with increasing depth. Higher soil moisture, bulk density, wheel slippage, theoretical field efficiency and effective field capacity were observed by cultivator at increasing depth and speed.

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