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Study of the effect of pre and post irrigation on different tillage treatments for different planter on soil's physical properties

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■ **ABSTRACT :** Sugarcane is a most important cash crop of India. It involves less risk and farmers are assured upto some extent about return even in adverse condition. In agriculture sector, sugarcane shared 7% of the total value of agriculture output and occupied 2.6% of India's gross cropped area during 2006-07. Sugarcane provides raw material for the second largest agro-based industry after textile. About 527 working sugar factories were located in the country during 2010-11 with total crushing capacity of about 242 lakh tonnes. The sugar industry is an instrumental in generating the sizable employment in the rural sector directly and through its ancillary units. It is estimated that about 50 million farmers and their dependents are engaged in the cultivation of sugarcane and about 0.5 million skilled and unskilled workers are engaged in sugar factories and its allied industries. Wheat-sugarcane-raton cropping system is followed in whole of western Uttar Pradesh and lower parts of Uttrakhand where sugarcane is the main cash crop and wheat is the major cereal. The system accounts for more than 60% of the total cultivated area in the region. However, lower average yield of planted cane (50 tonnes/ha) recorded in this. The reduction in cane yield owing to delayed planting cannot be compensated by additional inputs *viz.*, frequent irrigations, extra fertilizers and inter culture operations. Planting of sugarcane involves a number of operations *viz.*, cutting of canes into pieces called setts, opening of furrows, placement of fertilizer in the opened furrows, laying setts and covering these with a blanket of soil. The whole process of sugarcane planting is very labour and time intensive. In order to achieve uniform crop stand, correct seed rate, appropriate depth of setts placements and uniformity of setts with required overlapping are important. These, however can better be achieved by using tractor-drawn sugarcane cutter planter apart from economising labour and energy. Also there is a need to evolve proper tillage techniques for early planting of sugarcane in wheat-sugarcane crop sequence. In this paper study conducted on the performance of the effect of pre and post irrigation on different tillage treatments on soil's physical properties on the different types of sugarcane cutter planters.

■ **KEY WORDS :** Wheat harvesting, Pre and post irrigation, Sugarcane cutter planters, Rigid, Slit, Disc and furrower planter

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Cultivation of sugarcane in India dates back to the Vedic period. Different authors were of the opinion that the thin Indian canes probably originated in the moist parts of north eastern Indian, from some plants closely related to *Saccharum spontaneum* (Kans) belongs to family Gramineae (Poaceae). The

cultivated canes belong to two main groups: (a) thin, hardy north Indian types *S.barberi* and *S.Sinense* and (b) thick, juicy noble canes *Saccharum officinarum*. Highly prized cane is *S. officinarum*. It is probably evolved from *S. robustum* by introgression from other genera. It is agreed that the origin of *S. officinarum* is the Indo-Myanmar china border with New Guinea as the main centre of diversity.

Sugarcane (*Saccharum officinarum* L.) is an important food cum cash crop and cultivated between 320N to 320S latitude covering more than 90 countries of the world. Sugarcane contributes about 64.6%of the total world sugar production. India is one of the greatest producers of sugar and has a neck-to-neck race with Brazil for the first position. The country shares about 13.25 per cent of the World's and 41.11 per cent of Asian sugar production and cultivated in 4.10 million hectares with annual production of 300.25 million tonnes of cane and 18.90 million tonnes of sugar**.** The average yield of the crop is about 85.5 tonnes/ha, which is lower than that of the average productivity of Australia, Indonesia, Colombia, etc. In India, sugarcane crop is grown between 70 to 320 latitude covering large variations in climate, soil crop spread and productivity. The major area under this crop lies in subtropical belt comprising U.P., Uttaranchal, Bihar, Punjab, Haryana, Rajasthan and Madhya Pradesh.

Sugarcane involves less risk and farmers are assured upto some extent about return even in adverse condition. In agriculture sector, sugarcane shared 7% of the total value of agriculture output and occupied 2.6% of India's gross cropped area during 2006-07. Sugarcane provides raw material for the second largest agro-based industry after textile. About 527 working sugar factories were located in the country during 2010-11 with total crushing capacity of about 242 lakh tonnes. The sugar industry is an instrumental in generating the sizable employment in the rural sector directly and through its ancillary units. It is estimated that about 50 million farmers and their dependents are engaged in the cultivation of sugarcane and about 0.5 million skilled and unskilled workers are engaged in sugar factories and its allied industries. Some of the sugar factories have also diversified into by-products basis industries and have invested and put up distilleries, organic chemical plants, paper, ice board factories and cogeneration plant.

In India, sugarcane productivity has increased over the years but the magnitude has been very small. A wide gap exists between the potential and the realized productivity largely due to environmental constraints. In sub tropics, soil moisture during germination phase is usually low, resulting in poor sprouting of buds. Likewise, drought during the formative phase leads to poor tillring and elongation of shoots. Extremely low temperature at ripening stage impairs sucrose accumulation adversely affecting sugar and sugarcane productivity. On account of social taboos and other factors, farmers in north India take sugarcane after harvest of *Rabi* crops such as wheat, lentil, gram and mustard etc. which results in low yield. Planting sugarcane late in April or May after wheat harvest causes poor germination and does not allow enough period for till ring, resulting into less millable canes and low cane yield.

Based on abundance of genetic diversity of germplasm of *Saccharum* and its relatives and also cytogenetical and morphologic potential in the north-east region of India bordering Burma and China is believed to be the place of origin of *Saccharum officinarum*. The contention of Indian origin of sugarcane is ruled out with the lack of intermediate wild clone, such as *S. robustum* in India. New Guinea and the adjoining Island chains of Indonesian Archipelago are the two major centers of diversity for *S. officinarum* and *S. robustum*. *S. robustum* (2n = 60, 80) is believed to be the wild progenitor of *S. officinarum* (2n = 80). *S. robustum*, distributed naturally from new hybrids through New Guinea and Indonesia to Mindanao (Philippines) was believed to have evolved through introgression of *S. spontaneum*, *Erianthus* and *Miscanthus*. *S. spontaneum* (2n = 40 to 80) another wild species is distributed mainly in areas from Afghanistan (in west) to Malay Peninsula, Taiwan and South Pacific Island (In East). Based on cytological evidences, it is believed to have originated from introgression between *Erianthus* and *Sclenostachya*. The cultivated *S. barberi* is believed to have evolved through selection of *S. spontaneum* or through hybridization of *S. officinarum* and *S. spontaneum* in Bengal, Bihar and Orissa region of India. Tropical cane might have originated in some of the larger Islands of Oceania, most probably in New Guinea. Brandas (1956) also concluded that it was originated in New Guinea, where various forms of thick, tall, tropical canes have been cultivated from ancient times. From India, it probably entered into China, Arabia and Egypt

and after the crusades, it was introduced in Sicily, Portugal, the Canary Islands state into the new world. Kalbagal (1956) studied the influence of planting time on cane yield in Mysore reported that crop planted in the month of November and December produced significantly higher yield of 87.5 and 86.9 tonne/hectare, respectively than that of late planting. Vaidyanathan (1957) under southern condition (Tamil Nadu) observed that early January planting gave significantly higher cane yield of 106.5 tonne/hectare than that of May and September planting. Panje *et al.* (1965), while studied the sugar cane germination under different planting season at IISR, Lucknow found that October plant crop exhibited higher germination than February planted sugarcane. Paltooram (1970), reported that under Tarai conditions of Utter Pradesh February plant sugarcane recorded higher germination (46.90%) than that of October planted sugarcane (40.20%). Fashili and Malik (1974), from Pakistan reported that cane planted in the month of October gave significantly higher yield of 74tonne/hectare than that of planting in November, December, January, February and March. EI-Sharkawy and Sgaier (1975) found that as compared to no tillage, disking to 15-34cm depth and sub soiling to 50cm and 70cm depth increased rooting depth by 24,48,100 and 132%, respectively. Krall *et al.*(1978) and Payton *et al.* (1985) reported that double disc opener allowed straw to flow more smoothly and created more favourable seedbed than spear point and soil types in no till drill. Odigboh and Akubno(1990) reported that ridgers having mouldboards require more power to pull than those with disc. Shukla *et al.* (1984) developed a rotadurem sugarcane planter, which required two workers to feed the cane setts and a tractor operator. Preliminary test indicated that the field capacity of the machine was approximately 2 ha/day.

METHODOLOGY

Details of sugarcane cutter planter used for experimentation :

Method of planting :

Sugarcane can be planted by improved method of planting like, deep furrow, trench methods, ring pit method and paired row method instead of furrow system.

According to methods of planting, four types of the sugarcane cutter planters having ridger, slit, furrower and disc furrow openers were used for conducting the experiment and one conventional manual planter used as control. The technical details and specification are described below.

Ridger type planter:

This planter basically consists of 1650 mm long and 780 mm wide rectangular frame made of 60 ×60×60mm angle iron on which two ridger are mount with a provision to adjust row to row spacing from 750 to 900 mm two speed hoppers, each having cane capacity of 125kg and length, width and height of 570, 380 and 1380mm, respectively were mounted on the main frame which are made of 1.6mm thick M.S. sheet. Insecticide tank of 20 1itre capacity having dimensions of 710 ×250 ×210 mm is mounted on the frame. Another tank of 16 litre capacity is provided for the use of fungicide. It has two fertilizer boxes with star wheel type agitators along with circular plate having three sizes circular openings to meter the quantity of fertilizer. These boxes were made of trapezoidal shape having a cross section of 470×300 mm at the top 160×60 mm at the bottom with 350 mm height.

Disc type planter :

This planter consists of two 65 cm diameter discs, which are configured, and installed so as to produce V-shaped furrows. The discs are tilted vertically at an angle of 15^0 and having a disc angle of 20^0. Spacing between discs can be adjusted to obtain 750 mm to 900 mm row to row spacing. The cane cutting mechanism consists of two counter rotating blades. The blades are sharpened downward to prevent upward thrust on sugarcane stalks, Which are held by labourer during planting operation. There are two seats for two persons to be engaged for feeding the sugarcane.

Slit type planter :

Instead of disc type furrow opener as described in previous sugarcane cutter planter, slit type furrower type are used for making narrow furrows for cane planting. These are made from flat pieces of carbon steel welded together to form a cutting edge and bolted to the two points of rectangular cross section steel shank of size 3x1.5mm.

Furrower type planter :

This design employed a furrower for furrow opening. The power transmission for sett cutting is

through PTO of tractor. The planter have insecticides tank, fungicide tank and fertilizer box and have overall dimensions 2.18×2.80×3 m. It is heavier than other planters (550 kg) and it has insecticide tanks capacity of 100 litres and capacity of seed box is about 130 kg.

In this research we conducted a study on study of the effect of pre and post irrigation on different tillage treatments for different planter on soil's physical properties. The research has been conducted in the Fauladpur village, of Dhanaura Block in Amroha district of Uttar Pradesh state. There was a experiment carried out which was explained below: After harvesting of wheat by combine harvester straw left in the field was completely burnt. A main plot of 104.6m×53.3m was taken, which has a main irrigation channel and four sub irrigation channels of width of 1m and 0.5m, respectively. The whole experimental field was divided into six blocks of 8m x 100m size having homogenous field condition and each block was further divided in 10 equal parts of 8m x 10m size to accommodate sub plot treatments, different types of cutter planter with three replications. Soil parameters such as bulk density moisture content and infiltration rate were measured before tillage operation. Pre-irrigation was done before tillage operation to see its effect on germination and establishment of crop.

Experimental plan

Sr. No.	Particulars	Symbol
1.	Irrigation treatments	
	Pre- planting irrigation	I_1
	Post- planting irrigation	I_2
2.	Tillage treatments	
	Conventional tillage (1ploughing + 2 harrowing)	T_1
	Tillage operation by rotary tiller (2 rotavator)	T_2
3.	Planting treatments	
	Conventional practice (tractor operated ridger) (control)	P_0
	Disc type sugarcane cutter planters	P_1
	Slit type sugarcane cutter planters	P_2
	Ridger type sugarcane cutter planters	P_3
	Furrower type sugarcane cutter planters	P_4

Statistical design	:	RBD (Factorial 2 x 5 x 2)
Treatment combinations	:	2 x 5 x 2=20
Plot size	:	10m x 8m = 80 m^2
Total length of field	:	104.60 m
Total width of field	:	53.3 m
Gross area	:	104.60 m x 53.3m = 5575.18 m^2
Net area	:	100 m x 48 m = 4800m^2
Inter row spacing	:	80 cm
Main irrigation channel width	:	1 m
Sub-irrigation channel width	:	0.5 m
Total no. sub-irrigation channel	:	4
Bunds width	:	0.3 m
Total no. of bunds	:	12
Sugarcane variety	:	COS-767

Testing procedure :

The same testing procedure was adopted for experiment. The sugarcane seed variety COS-767, was kept at both ends as well as in the middle of the experimental plot to ensure regular and smooth seed availability for the planter so as to minimize seed filling time during planting. MASSI 241 tractor was used in II low gear at 2000 and 1500 engine rpm during experiment. Two persons were employed for feeding the canes into sett cutting units. The distance travelled in 8 revolution of tractor and 13 revolution of ground wheel was measured separately to determine the tractor wheel slippage and ground wheel skid, respectively. Time taken to cover the distance of 73m in first and 48m in second experiment.

RESULTS AND DISCUSSION

In this research, pre and post irrigation was scheduled to improve the quality of the soil. Since, planting of the sugarcane crop has done just after the harvesting of wheat crop. So the moisture value in the soil was low. So the effect of the pre and post irrigation method has considered for the research and it was major things for the physical property of the soil before the tillage treatment.

Bulk density :

The soil bulk density (g/cc) was measured in 0-15 cm and 15-30 cm soil depth to determine the level of compaction before tillage operations and to adjudge level of seedbed preparation after each tillage treatment. The initial soil bulk density for post irrigation for 0-15 and 15-30 cm depth was 1.34 and 1.41 g/cc, respectively while for pre irrigation or 0-15 and 15-30 cm depth was 1.29 and 1.38 g/cc, respectively (Table 1).

Soil bulk density, after each tillage treatment measured at 0-15 cm depth was minimum 1.09 g/cc in treatment T_2 (rotavator x 2) in both years followed by 1.14 g/cc in 2014-15 and 1.13 g/cc in year 2016 in T_1 (ploughing x 1 + harrowing x 2) in pre irrigation techniques. At 15-30 cm depth, the bulk density varied from 1.31 to 1.44 g/cc being lowest in case of T_2 (rotavator x 2) for the year 2014-15 and the highest for

T_1 (ploughing x 1 + harrowing x 2) and the highest for T_2 (rotavator x 2) for post irrigation.

From the above results, it is clear that bulk density decreased to a greater extent at both depths 0-15 and 15-30 cm as compared to the initial bulk density of 1.34 g/cc.

Soil moisture content :

The mean values of soil moisture content at the beginning and end of the tillage treatments are presented in Table 1. The initial moisture content measured at 0-15 and 15-30 cm depth was found 15.18 and 15.90%, respectively while in pre irrigation 14.44 and 14.93%, respectively in post irrigation. After tillage operations, higher moisture content (14.77 and 15.09%) was recorded under tillage T_1 at 0-15 and 15-30 cm depth, respectively in pre irrigation while minimum moisture content of 13.78% was found in T_1 in post irrigation at 0-15cm depth. However, moisture content at 15-30 cm depth varied from 14.48 to 15.50% being lowest in T_2 (rotavator x 2) as 14.48% in post irrigation.

Higher moisture content in T_1 tillage treatment for both depths might be due to reduced capillaries size resulting into less surface evaporation losses. In other treatments soil was quite loose having higher capillary movement which might be caused more depletion of soil moisture.

Clod mean weight diameter :

Clod mean weight diameter (CMWD) measured after completion of tillage operations is presented in Table 1. It may be seen from the table that the minimum CMWD 1.07 mm was observed in case of T_2 (rotavator x 2) in post irrigation followed by 1.76 mm in T_{1-} (ploughing x 1 + harrowing x 2) in pre irrigation. The minimum CMWD in T_2 may be due to cutting of smaller soil slices and greater pulverization of soil by the action of rotavator blades as compared to other tillage equipment. The maximum CMWD 13.76 mm was observed in case of T_1– (ploughing x 1 + harrowing x 2) in pre irrigation followed by 9.85 mm in T_2 (rotavator x 2) in post irrigation.

Above CMWD data showed that better tilth may be obtained by performing only two operations of rotavator rather than going for three to four harrowing.

Infiltration rate :

Data on infiltration rate was recorded at the beginning prior to tillage treatments and after two days of planting of sugarcane. The values of infiltration rates are given in Table 1.

The initial infiltration rate of experimental field was

Table 1 : Influence of different tillage treatments on soil physical properties and tillage depth of experiment plot for the years 2014-15 and 2015-16

Sr. No.	Parameters	Depth, (cm)		Tillage Treatment			
				T_1		T_2	
				2014-15	2015-16	2014-15	2015-16
1.	Moisture content, (%)	Pre irrigation	0-15	14.77	14.75	14.65	14.74
			15-30	15.09	15.19	15.10	15.20
		Post irrigation	0-15	13.92	13.78	13.91	13.82
			15-30	14.50	14.49	14.48	14.49
2	Bulk density, (g/cc)	Pre irrigation	0-15	1.14	1.13	1.09	1.09
			15-30	1.32	1.35	1.44	1.31
		Post irrigation	0-15	1.26	1.26	1.22	1.22
			15-30	1.27	1.37	1.34	1.33
3	Clod mean weight diameter, (mm)	Pre irrigation	0-15	13.76	13.76	4.59	4.60
			15-30	7.74	7.68	1.76	1.76
		Post irrigation	0-15	9.72	9.85	2.47	2.47
			15-30	2.45	2.45	1.07	1.07
4	Infiltration rate, (cm/h)	Pre irrigation		0.49	0.49	0.41	0.41
		Post irrigation		0.60	0.60	0.50	0.50
5	Depth of tillage, (cm)	Pre irrigation	0-30	21.87	21.87	13.57	13.57
		Post irrigation	0-30	0.99	0.99	15.43	15.43

0.28 cm/h. The data revealed that minimum infiltration rate of 0.41 cm/h was noted in T_2 (rotavator x 2) followed by 0.49 cm/h in T_1 (ploughing x 1 + harrowing x 2) in pre irrigation. Higher infiltration rate 0.60 cm/h in post irregation under T_1 (conventional tillage) treatment may be due to higher porosity caused by loosening of soil to a greater depth and soil could absorb more water if it given after tillage. The minimum infiltration rate in pre irrigation plot was because of greater consolidation and compaction of soil particles which increased the moisture retaining micro-capillary pores and reduced macro-capillary pores**.**

On the basis of above study, it may be concluded that the field preparation by T_1 (ploughing x 1 + harrowing x 2) may be considered better as the bulk density was low at higher depth which may facilitate better plant stand, root growth and ramification of the root system by reducing mechanical impedance of the soil. Although the moisture content was higher in T_2 amongst all tillage treatments but T_1 was also having sufficient moisture content at the time of sugarcane planting. Results showed that the clod mean weight diameter was nearly same in all tillage treatments as field was prepared to equally tilth. Treatments T_1 (ploughing x 1 + harrowing x 2) and T_2 (rotavator x 2) exhibited smaller clods which is preferred for sugarcane planting with respect to tilth requirement. Also these treatments showed higher soil-water storage because of high infiltration rate and smaller size of soil particles, thereby increasing nutrient concentration in soil solution and higher root growth.

Conclusion :

After the observation of the performance of the different types of the sugarcane cutter planter for different tillage and different field condition, it is found that the conventional tillage T_1 (ploughing x 1 + harrowing x 2) is good for all the cutter planters in all terms in the form of bulk density(1.44%), soil moisture(15.20 %), CMWD(13.76cm) and infiltration rate(0.60 cm/h) and it is also used by many farmers but we also want to know that which planter gave the best result in terms of productivity, energy consumption and the economical point of view for the purpose of sugarcane plantation after wheat harvesting.

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