To Study of the Different Modes of Tillage for the Performance of Sugarcane Cutter Planter

Manish Kumar[1], Prof. Ashok Tripathi[2]

[1] *M.Tech Farm Machinery and Power Engineering, Vaugh School of Agriculture Engineering and Technology, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed-to-be University), Allahabad-211 007, UP, India)*

[2] *Professor, Farm Machinery and Power Engineering, Vaugh School of Agriculture Engineering and Technology, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed-to-be University), Allahabad-211 007, UP, India)*

---***---

Abstract- *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. These operations are sometimes modified to suit the varying agro climatic conditions in different parts of country and are performed either manually with spades or furrows are opened with help of animal drawn or tractor drawn ridge and sugarcane sets are placed and covered manually. 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 we studied the effect of different tillage treatments on the performance of ridge type sugarcane cutter planter in relation to timely planting of sugarcane after wheat harvest and also evaluate the performance of different sugarcane cutter planters under zero and conventional tillage.

Key Words: Sugarcane, Tillage, Rigid type sugarcane cutter planter.

1. INTRODUCTION

Sugarcane (Saccharum officinarum L.) is an important cash crop and cultivated between 32^0N to 32^0S 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 percent of the World's and 41.11 percent[1,2,3] of Asian sugar production and it is cultivated in 4.10 million hectares with annual production of 300.25 million tonnes of cane and 18.90 million of sugar. The average yield of the crop is about 85.5 tonnes/ha [4, 6], which is lower than the average productivity of Australia, Indonesia, Colombia, etc. In India, Sugarcane crop is grown between 7^0 to 32^0 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 [5, 7, 8]; which accounts for about 70% of the cane area and 50% of the cane production. Utter Pradesh and Uttaranchal states collectively contribute 49.74% of the total cane area and 44.34% of the total cane production in India. The contribution of other states such as Maharashtra is 12.67% in area, 15.1% in production, Tamil Nadu 6.54% in area, 9.9% in production, Kama taka 6.29% in area, 6.29% in area, 8% in production, Andhra Pradesh4.91%in area.5.42%in production [9, 10, 11], Punjab 4.27%in area, 4.11%in production, Haryana 4.04% in area, 3.55%in production and Gujarat 3.7% in area, 5.68%of cane production scattered in rest of states[12, 13, 14, 15],. Out of total sugar production in India, 47%of cane is used for sugar manufacturing, 40% is diverted for Guar and Khan Sari production and 13%is used for seed and juice purpose[17].

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 till ring and elongation of shoots. Extremely low temperature at ripening stage impairs sucrose accumulation adversely affecting sugar and sugarcane productivity [18,19, 20]. 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 mill able canes and low cane yield.

2. ORIGIN AND HISTORICAL BACKGROUND

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 by Daniels and Roach (1987). New Guinea and the adjoining Island chains of Indonesian Archipelago are the two major centres 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) [21, 20]. 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-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 (TamilNadu) observed that early January planting gave significantly higher cane yield of 106.5 tonne/hectare than that of Mayand 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%). Fasihi 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. El-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. (1978) 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.

3. METHODOLOGY

In this section we are discussed about the details of materials used, experimental methodology followed and measurement techniques adopted during the course of study

3.1 Details of Experimental Field

The investigations were carried out at the experimental plots located near the "Project Directorate of Farming Research System, Meerut. The centre is situated at 29N latitude, 79.5E longitude and 243.84 m altitude above the mean sea of the Shiwalik range of the Himalayas. Both minimum and maximum temperatures fluctuated throughout the crop period. The lowest temperature was 7.28^{0}C, 5.02^{0}C and 5.09^{0}C respectively. The highest temperature was 34.25^{0}C and 35.30^{0}C respectively. The mean relative humidity varied from 50.50 to 80.00 percent and from 55.30 to 80.00 percent respectively. The mean sun-sine period varied from 4.40 to 9.40 hours and from 5.5 to 9.3 hours. The total rainfall recorded was 2000.8. and 1818.80 mm, respectively.

3.1.1. Climate and Weather Conditions

Meerut is located in the heart of Tarai belt characterized by sub-tropical and humid climate, where summer is hot and winters are severe. It remains dry from early October to mid-June. Generally, south-west monsoon sets in the third week of June and continues up to September. Very often, a few showers are also expected during winters.

3.1.2. Soil Characteristics

The soil of the experiment site is of alluvial origin, fine silty, mixed hyperthermia and belongs to series II silty clay loam. The physio-chemical properties of experimental fields are given in Table 1.

3.2 Details of Sugarcane Cutter Planter Used for Experimentation

Three types of the sugarcane cutter planters having ridger, slit and disk furrow openers were used for conducting the experiment. The technical details and specification are described below.

3.2.1 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, 380and 1380mm respectively were mounted on the main frame which are made of 1.6mm thick m.s. sheet. Insecticide tank of 20.1capacity having dimensions of 710 ×250 ×210mm is mount of the farm another tank of 20.1capasity 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, the capacity of fertilizer box in approximately 25 kg. The tractor PTO through a chain and sprocket drive operates the fertilizer meat ring system. The sett cutting mechanism consists of two cutting units, one of each row.

Table:1 Physio-chamical properties of experimental fields

Sr. No.	Property	Year 2011	Year 2012	Method used
1.	Composition (I)Sand (%) (ii) Silt (%) (iii)Clay (%)	 8.9 61.4 29.7	 8.8 61.4 29.9	Bouyoucos hydrometer method
2.	Textural class	Silty clay loam	Silty clay loam	International system
3.	Initial Bulk density (g/cc)	1.35	1.37	Core sample method
4.	Electrical conductivity (d Sm^{-1})	0.80	1.00	Conductivity bridge
5.	PH(1/2.5 soil water suspension)	7.35	7.30	Beckman glass electrode pH meter
6.	Organic carbon (%)	0.96	0.93	Modified Walkley and Black method
7.	Available Nitrogen (kgN/ha)	294.70	296.87	Modified Kjeldahal Method
8.	Available phosphorus (kgP_2O_5/ha)	32.75	33.05	Olsen's method
9.	Available potassium (kg K_2O /ha)	298.31	300.01	Natural normal ammonium acetate method)

Cutting unit consists of two revolving knives place at 180^0 apart and mount on 150 mm diameter solid m.s. disc having 10 mm thickness. The length, width and thickness of each knife is 170 mm, 5mm and 3 mm respectively.

3.2.2. 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 750mm to 900mm 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.

3.2.3. Slit type planter

Instead of disc type furrow opener as described in previous sugarcane cutter planter, slit type furrower 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.

Table 2 Technical specifications of sugarcane cutter planters

Sl. No.	Particulars	Specification
1	Source of power	Tractor
2	Power transmission	Ground wheel (Disc and slit type) P.T.O.(Ridge type)
3	Overall dimensions	
	Length, m	1.55
	Width, m	1.15
	Height, m	2.25
4	Weight, kg	3400
5	Type of hitch	3 point (mounted)
6	Furrowers used	Ridger, Disc and Slit types
7	Capacity of insecticide tank, l	20
8	Capacity of fungicide tank, l	20
9	Capacity of fertilizer box, kg	25
10	Row to row spacing, cm	Adjustable within 75.0-90.0
11	Capacity of seed box, kg	125
12	Dimension of seed box	
	Length, cm	57.0
	Width, cm	38.0
	Height, cm	138.0

3.3 Experimental details and layout plan

Two experiments were carried out.

3.3.1 First experiment

The first experiment was conducted to evaluate the performance of sugarcane cutter planter under different

Table 3 First experiment

Sl. No.	Particulars	Symbol
A.	Main plot	
	I. Post- planting irrigation	I_0
	II. Pre-planting irrigation	I_1
	Sub plot (tillage treatments)	
B.	I. Conventional tillage (1ploughing + 4 harrowing)	T_1
	II. Conventional tillage(2 harrowing only)	T_2
	III. Tillage operation by rotary tiller(2 rotavator)	T_3
	IV. Tillage operation by rotary tiller(1 rotavator)	T_4
	V. Zero tillage	T_5

modes of tillage in relation to early planting of sugarcane. The treatments details are given below:

Statistical design : RBD with four replications
Treatment combination : 5x2x4=40
Plot size : 15mx6m = 90m²
Gross area : 73mx65m= 4745m²
Net area : 60mx60m = 3600m²
Inter row spacing : 75 cm
Sugarcane variety : COS-767

3.3.2 Second experiment

The second experiment was carried out to evaluate the performance of different cane cutter planters under zero and conventional tillage condition. The details of experiment are given below:

Table 4 Second experiment

Sl. No.	Particulars	Symbol
A.	Main plot	
	I. Post- planting irrigation	I_0
	II. Pre- planting irrigation	I_1
B.	Sub plot(Tillage treatments)	
	I. Zero tillage	NT
	II. Conventional tillage(1 ploughing + 4 harrowing)	T
C.	Sub-sub plot (Cane cutter planters)	
	I. Disc type sugarcane cutter planters	D
	II. Silt type sugarcane cutter planters	S
	III. Ridger sugarcane cutter planters	R

Statically design : Split plot with three replications
Treatment combinations : 2x2x3x3=36
Gross area : 105mx55m=5775m²
Net area : 90mx45m=4050m²
Plot size : 15mx7.5m=112.50m²
Inter row spacing : 75cm
Sugar cane variety : COS-767

3.4 Experimental procedure

Two experiments were carried respectively to study various tillage treatments including zero tillage for advancing planting of sugar cane after wheat harvest.

3.4.1 Field preparation of first experiment

After harvesting of wheat by combine harvester straw left in the field was completely burnt. The whole experimental field was divided into eight blocks of 15mx30m size having homogenous field condition and each block was further divided in five equal parts of 15mx6m size to accommodate sub plot treatments. Soil parameters such as bulk density moisture content and infiltration rate were measured before tillage operation as presented in table 5. Pre-irrigation was done before tillage operation to see its effect on germination and establishment of crop.

Table.5 Initial condition of experimental plot

Replication	Bulk density, g/cc		Soil moisture content, %	
	Depth, cm		Depth, cm	
	0-15	15-30	0-15	15-30
R_1	1.36	1.38	14.70	15.87
R_2	1.30	1.42	15.45	16.32
R_3	1.35	1.42	15.38	15.51
R_4	1.38	1.40	15.62	16.27
Average	1.35	1.41	15.30	16.00

All tillage operations were performed with the help of tractor drawn implements viz. vertical disc plough, offset disc harrow and rotavator. After completion of tillage operations, the entire field was levelled by tractor drawn leveller. Again bulk density, moisture content, cloud mean weight diameter and infiltration ere recoded before planting the lots.

3.4.2 Field preparation of second experiment [27]

The residue left over the experimental field after wheat harvest was burnt. The whole field was divided into main plots of 47.5mx55m size and each main plot was further divided into nine plots of 15mx7.5m size to accommodate the different types of sugarcane cutter planters with three replications. In the conventional tillage treatment, field was prepared by 1 ploughing + 4 harrowing operations and thereafter tractor drawn leveller were used. Soil parameters such as bulk density, moisture content and infiltration rate were measured and presented in table 6.

Table.6 Initial condition of experimental plot

Replication	Zero tillage(NT)				Conventional tillage(T)			
	Bulk density, g/cc		Moisture content, %		Bulk density, g/cc		Moisture content, %	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
R_1	1.38	1.39	15.20	15.89	1.21	1.23	13.92	14.50
R_2	1.29	1.32	15.09	16.05	1.19	1.23	14.09	14.40
R_3	1.33	1.40	15.15	15.80	1.21	1.25	13.87	14.77
R_4	1.36	1.38	14.97	15.96	1.22	1.36	14.06	14.62
Avg.	1.34	1.37	15.10	15.93	1.21	1.24	13.99	14.57

3.5 Measurement of Different Parameters

The measurement techniques of various parameters involved in the field experiments are described in the following section:

3.5.1 Soil moisture content [21,24]

Soil samples were collected randomly for four locations at 0 to 15cm and 15 to 30 cm depth of each test plot. The moisture content was determined through oven dry method by keeping known amount of weight in the oven at 105^{0}C for 24 hours with the help of following relationship:

$$M_c = \frac{W_1 - W_2}{W_2} \times 100$$

Where,

M_c=Moisture content (d.b.),%

W_1=Weight of the sample,g

W_2=Weight of the oven dry sample,g

3.5.2 Bulk density [21,22]

The bulk density of soil was determined using core sampler kit having 100mm diameter and 150mm length. It was inserted into soil at four locations selected randomly. Two samples from 0-15cm and 15-30cm range were taken from determining, the bulk density of experimental plots. The excess soil at both the ends of the sampler was trimmed with the help of a sharp knife. Samples were weighed and kept in the oven at 105^{0}cC for 24 hours. The weight of dry samples was recorded and bulk density on dry weight basis was calculated by using following relationship:

$$P = \frac{m}{v}$$

Where,

P=Bulk density of soil (d.b.),g/cc

M=weight of oven dry sample,g

V=volume of the core sampler,cc

3.5.3 Clod mean weight diameter [21,22]

After seedbed preparation, a steel frame of 50x50cm was placed in each plots except in case of zero-tillage treatment and clods along with fine soil particles were collected manually for analysis. The sample retained on each sieve was weighed and clod mean weight diameter of the soil aggregates was calculated using the following formula:

$$CMWD = \frac{\sum_{i-1}^{n} W_i d_i}{\sum_{i=1}^{n} W_i}$$

Where,

CMWD = Clod mean weight diameter,mm

W_i=Weight of soil sample retained over the Ithsieve,g

D_i=class mean size of the Ithsieve,g

3.5.4 Infiltration Rate [21, 28]

For measuring infiltration rate, double ring infiltrometer was used which has 30cm and 50cm diameter and 20cm height. A constant head water supply unit was installed to maintained a head of 5cm on the soil surface. The volume of water going into the soil was recorded at 15th, 30th.60thand 120th minutes where infiltration became negligible. From the recorded data, infiltration rate was calculated for each treatment.

3.5.5 Speed of operation

The time required to travel across the test plot for each experiment was recorded with the help of a stopwatch and forward speed of tractor was calculated in kmph for each case.

3.5.6 Fuel consumption[29,30]

The fuel tank of tractor was topped up on levelled surface before starting the planting operation. At the end of operation, the tractor was again brought to the same surface and fuel was filled in the tank up to the top with the help of measuring cylinder and quantity of fuel required to fill the tank was recorded. The fuel consumption was estimated in 1\ha.

3.5.7 Field efficiency

To determine the field capacity (ha\h) of the machine was estimated with the help of planting width of the machine and speed of the operation. Thereafter, the field efficiency was calculated by dividing effective field capacity with theoretical field capacity and expressed in percentage.

3.5.8 Tractor wheel slippage [23,25]

In order to determine tractor wheel slippage, a mark with the help of chalk was made on the tractor rear wheel. The percentage slippage was calculated with the help of following relationship:

$$\text{Tractor-wheel slippage,\%} = \frac{d_1 - d_2}{d_1} \times 100$$

Where,

D_1=Distance travelled with no load in 8 revolution, m

D_2 =Distance travelled with load in 8 revolution, m

3.5.9 Ground wheel skid

The revolutions of ground wheel were counted at the time of planting and distance travelled for 13 revolutions was measured.

3.5.10 Depth of planting

The depth of planting was measured with the help of a steel scale after digging the planted canes. The readings were taken randomly at three locations in each replication. Average depth of planting was calculated by tacking the mean of all readings.

3.5.11 Overlapping

The percentage overlapping of the setts was estimated by the following relationship:

$$\text{Percent Overlapping} = \frac{1_s - 1_p}{1_p} \times 100$$

Where,

L_s=Total sett length in 5 m planted distance, cm

L_p=Observed distance in 5 m

3.5.12 Seed rate

The weight of setts dropped in 5m length was determined by physical balance. The seed rate ,kg\ha was calculated as follows:

Seed rate, kg/ha=

$$\frac{Quantity\ of\ seed\ dropped\ in\ 5m, kg}{5 \times 0.75} \times 100 \times 100$$

= Quantity of seed dropped in 5m,kgx 2666.7

3.5.13 Germination [28]

The number of shoots per plot were counted at 30 days and 60 days interval after sugarcane planting and percent germination was worked out as follows:

Percent germination =

$$\frac{Number\ of\ shoots\ per\ plot}{Number\ of\ bud\ per\ plot} \times 100$$

3.5.14 Cane yield

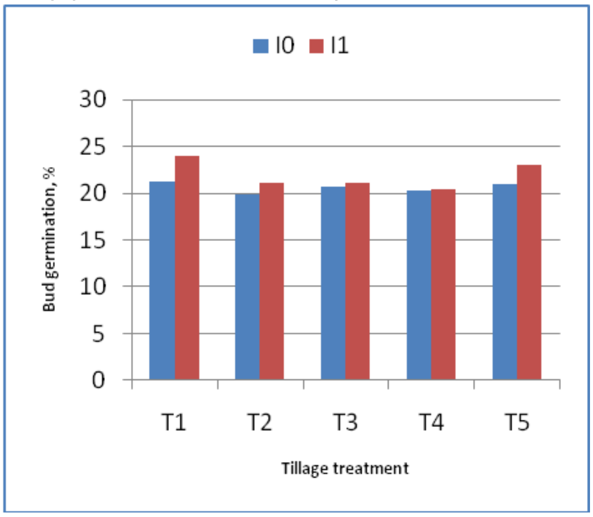
Harvesting of each experimental plot was done at maturity. Green and dry leaves were stripped off and weights of canes were recorded with the help of platform balance and yield was worked out on hectare basis.

4. RESULTS AND DISCUSSION

In wheat sugarcane-ratoon cropping system, time available for seedbed preparation for planting of sugarcane crop after wheat harvesting is very limited. The turnaround time for sugarcane planting after wheat is only 10 to 15 days and delay in its planting causes substantial reduction in cane yield. Considerable amount of time and energy are also consumed in tillage operations. Therefore, in order to minimize energy requirement of tillage operations and advance sugarcane planting after wheat crop harvest, a comprehensive study was under taken to evaluation performance of different type of sugarcane planters under various modes of tillage treatments with pre and post-planting irrigation. Keeping these points in view, two field experiments were carried out.

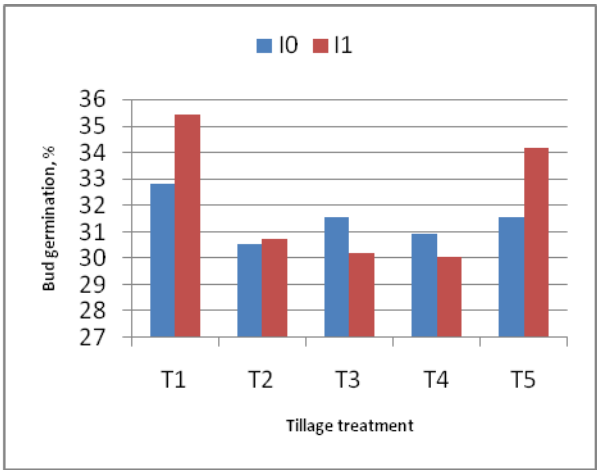
In first experiments, influence of different tillage treatments viz., one ploughing and four harrowing (T_1), two harvesting (T_2), twice rotavator (T_3), once rotavator (T_4), and zero tillage (T_5) were evaluated with respect to soil and machine parameters and crop responses. Energy requirements in seedbed preparation were also worked out to evaluate the energy use efficiency in term of per tonne of cane productivity shown in the table 8. Based on the first field experiments, following results are found.

The bulk density as decreased after tillage treatments in 0-15 as well as in 15-30 cm soil layer which varied from 1.10 to 1.35 and 1.20 to 1.41 g/cc, respectively. The minimum bulk density in 0 -15 and 15-30 cm soil layer was obtained in case of T_3 (rotavator × 2) and T_1 (ploughing × 1 + harrowing × 4), respectively, whereas it was maximum in T_5 (zero tillage) treatments at both depths.



Maximum moisture content (15.30 and 1600% was obtained in case of zero tillage (T_5) at both depth range 0-15 and 15-30 cm whereas, minimum was recorded as 13.43% in treatments T_3 (rotavator × 2) and 14.49% in case of T_3 (ploughing × 1 + harrowing × 4) for depth range of 0-15 and 15-30 cm, respectively.

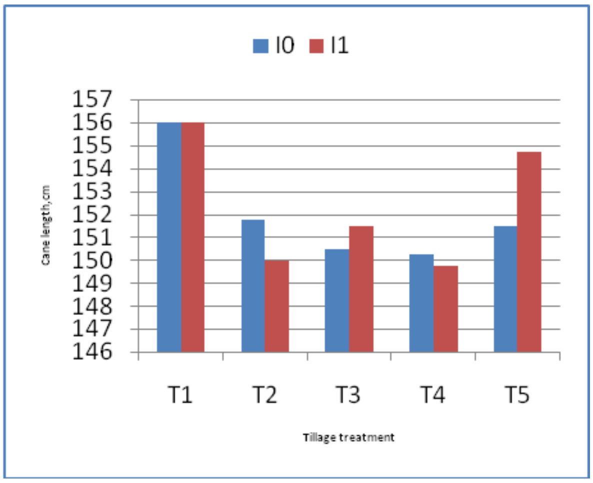
Minimum and maximum cold mean weight diameter of 11.50 mm and 14.70 mm were found in T_3 (rotavator × 2) (harrowing × 2) treatments, respectively.



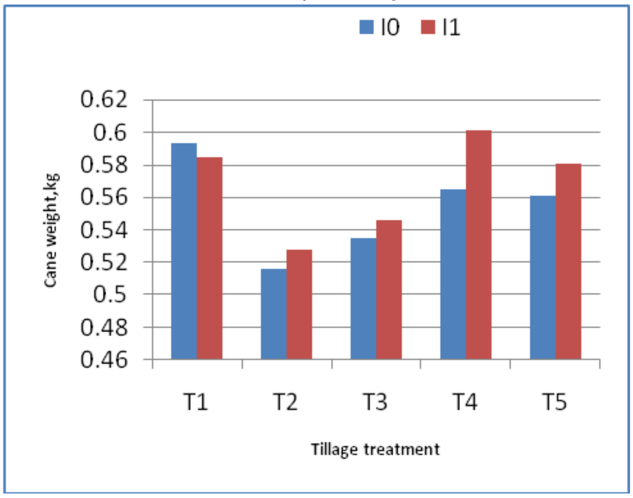
Infiltration rate increased with the level of tillage treatments. Lower and higher infiltration rates of 0.26 and 0.47 cm/ h were obtained in case of T_5 (zero tillage) and T_1 (ploughing × 1+ harrowing × 4) treatments, respectively.

No significant differences were observed in number of setts under various tillage treatments for pre and post –planting irrigated field conditions. Number of sets in 5 m under above field conditions varied from 21 (T_3) to 22 (T_5) and 21.25 (T_3) to 23(T_5), respectively.

Average sett length was found to be non- significant among tillage treatments as well as field conditions which varied from 31.06 ± 1.56 cm (T_5) to 32.10 ± 0.88 cm (T_1) and 30.30 ± 1.44 cm (T_5) to 31.81 ± 2.13 cm (T_3) under per and post-planting irrigated field conditions, respectively.



The variation in the seed rate was no significant under various tillage treatments as well as field conditions, which range from 6080 to 6320 kg/ha (being lowest and almost same in treatments T_1, T_3, T_4 and highest for zero tillage) under both conditions, respectively.



There was no significant difference in bud damage among tillage treatments as well as field conditions. Bud damage varied from 3.91% (T_5) to 5.49% (T_4) and 5.01 % ((T_2) to 6.20% (T_3), respectively under pre and post- planting irrigation conditions.

The variation in the overlapping of the sett were significant under various tillage treatments as well as field conditions ranging from 33.79 (T_1) to 36.32% (T_5) and 34.62 T_1 to

39.08% (T_5), respectively under pre and post irrigated conditions. The missing are has also been found significant among tillage treatments as well as field conditions.

Table 7 Bud germination after 30 days of planting

Sl. No.	Treatment	Bud germination, %				
		R_1	R_2	R_3	R_4	Mean
1.	T_1I_1	23.81	24.03	22.39	25.69	23.98
2.	T_2I_1	20.45	21.62	20.27	22.26	21.15
3.	T_3I_1	19.00	24.78	16.55	24.05	21.09
4.	T_4I_1	21.75	17.45	21.02	21.46	20.42
5.	T_5I_1	22.62	23.28	22.79	23.52	23.05
6.	T_1I_0	21.67	18.91	20.22	24.38	21.30
7.	T_2I0	20.86	19.38	14.51	24.61	19.84
8.	T_3I_0	21.42	16.82	18.72	25.93	20.72
9.	T_4I_0	17.49	18.06	22.10	23.36	20.25
10.	T_5I_0	22.26	20.06	20.49	21.35	21.04

The minimum and maximum missing area was observed in zero tillage (2.84 and 2.07%) and in T_1 (4.26 and 3.67%) for both pre and post- planting irrigated fields.

Table 8 Bud germination after 60 days of planting

Sl. No.	Treatment	Bud germination, %				
		R_1	R_2	R_3	R_4	Mean
1.	T_1I_1	35.08	37.67	32.33	36.59	35.42
2.	T_2I_1	34.49	26.31	21.2	40.91	30.73
3.	T_3I_1	33.94	24.72	28.12	34.04	30.21
4.	T_4I_1	28.39	25.39	29.85	36.53	30.04
5.	T_5I_1	35.5	32.89	31.69	36.54	34.16
6.	T_1I_0	31.74	31.18	31.67	37.6	32.80
7.	T_2I0	34.77	28.24	20.05	39.11	30.54
8.	T_3I_0	32.26	31.23	24.23	38.49	31.55
9.	T_4I_0	36.68	24.27	26.75	35.94	30.91
10.	T_5I_0	32.68	30.94	27.42	35.18	31.56

Significant difference in tractor wheel slippage was observed for both field conditions as well as tillage treatments. It varied from 5.23 to 8.23% and 4.97 to 7.92% (being lowest for T_5 and highest in case of T_1 treatment) under pre and post- planting irrigated fields, respectively. The variation in filed capacity was found no significant which range from 0.26 to 0.27 ha/h under all tillage treatments as well as under both field conditions.

There was no significant effect of tillage treatments and field conditions on germination, cane length, weight girth and number of malleable canes. However, above parameters were of greater value in T_1 (ploughing × 1 + harrowing × 4) treatments. No significant difference in cane yields was recorded under pre and post- planting irrigated fields as well as tillage treatments. The cane yield varied from 50.91 to 56.01 t/ha and 50.67 to 55.87 t/ha being lowest for (T_2 and highest in case of T_5 (zero tillage) under both field conditions, respectively.

Energy use for seedbed preparation under various tillage treatments for pre and post- planting irrigated field was maximum in T_1 (43.78 and 44.14 MJ/tonne) followed by treatments T_3 (43.36 and 43.65), T_4 (21.14 and 21.31) and T_2 (17.81 and 17.90 MJ/tonne), respectively whereas no energy was required in case of treatments T_5 (zero tillage).

The second field experiments was carried out after harvesting of wheat to investigate suitability of type of cane planters under zero and conventional treatments in per and post- planting irrigated field conditions. Performance of three cane planters having ridger, slit and disc type furrow openers was evaluated in terms of soil, machine and crop response parameters. Based on findings, following inferences were drawn:

The maximum bulk density of 1.34 and 1.37 g/cc was obtained in case of zero tillage as compared to conventional tillage (1.18 and 1.23 g/ cc) for both depth ranges of 0-15 and 15-30 cm , respectively.

Moisture content was found maximum in case of zero tillage (15.10 and 15.93%) in comparison to conventional tillage (13.87 and 14.51%) for above two depth ranges. Infiltration rates of 0.29 and 0.48 cm/h were obtained in case of zero and conventional tillage treatments, respectively.

Number of setts in 5 m length was observed to be significant higher in zero tillage condition ranging from 16.67 to 22.00 and 17.33 to 23.33 under pre and post planting irrigation. The number of setts was found significantly higher in case of zero tillage as compared to conventional tillage treatments. The average sett length was maximum in case of conventional tillage which range from 31.76 to 42.58 cm and 31.03 to 40.61 cm under pre and post- planting irrigation as compared to zero tillage treatments which varied 30.92 to 37.67 and 29.88 to 36.67 cm under above field conditions respectively. It was found highest for slit type planter and lowest in case of ridger type cane planter under both field conditions as well as tillage treatments.

Table 7 Influence of different tillage treatments on the performance of sugarcane planter under pre and post-planting irrigated field condition

Sl.No.	Parameter	pre-planting irrigated				post-planting irrigated				
		T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4
1.	Average number of setts, in 5m	21.00	21.25	21.00	21.25	22.00	21.50	22.00	21.25	21.75
2.	Average sett length, cm	32.10 $\pm$0.88	31.57 $\pm$1.62	31.97 $\pm$1.95	31.64 $\pm$1.25	31.06 $\pm$1.56	31.53 $\pm$1.97	30.89 $\pm$0.92	31.81 $\pm$2.13	31.28 $\pm$1.75
3.	Average weight of setts in 5m, kg	2.28	2.30	2.28	2.28	2.37	2.32	2.37	2.31	2.33
4.	Average number of buds in 5m	67.25	68.00	66.75	68.75	70.25	68.5	69.75	68.75	68.25
5.	Average number of damage dubs in 5m	3.50	3.25	3.50	3.75	2.75	3.75	3.50	4.25	3.75
6.	Average % bud damage	5.20	4.77	5.24	5.49	3.91	5.47	5.01	6.20	5.49
7.	Average % overlapping	33.79	34.29	33.81	34.71	36.32	34.62	35.81	35.04	35.93
8.	Average % missing	4.26	3.76	3.87	3.65	2.84	3.67	3.29	3.55	3.14s
9.	Seed rate, Kg/ha	6080	6133	6080	6080	6320	6287	6320	6160	6214
10.	Depth of planting, cm	22.67	21.43	21.33	20.67	20.25	21.83	21.42	30.91	20.47
11.	Speed of operation, Km/h	2.93	3.01	2.99	2.96	3.08	3.02	3.05	3.08	3.12
12.	Effect field capacity, ha/h	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.27
13.	Cane filling time, h/ha	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59
14.	Field efficacy, %	59.09	56.52	56.52	59.09	58.70	58.70	58.70	58.7	57.45
15.	Fuel consumption, l/ha	12.86	12.62	13.09	12.71	12.38	12.23	12.14	12.95	12.48
16.	Tractor wheel slippage, %	8.23	8.04	8.12	7.86	5.23	7.92	7.51	7.80	6.94

Table 8 Energy requirement for seed bed preparation under different tillage treatments

Si, No.	Treatments	Direct energy				Indirect energy				Total energy, MJ/ha	Cane yield, t/ha		Energy, MJ/tonne	
		Human		fuel		Tractor		tillage			Pre-planting irrigation	Post-planting irrigation	Pre-planting irrigation	Post-planting irrigation
		H	MJ	L	MJ	h	MJ	H	MJ					
1.	T_1,ploughing× 1	2.50	4.90	9.80	551.84	2.50	25.65	2.50	43.90	2398.53	54.79	54.34	43.78	44.14
2.	Harrowing× 4	7.04	13.79	27.75	1562.0	7.04	72.23	7.04	123.62	_	_	_	-	_
3.	T_2,(harrowing × 2)	3.60	7.06	14.20	799.60	3.60	36.93	3.60	63.22	906.82	50.91	50.67	17.81	17.90
4	T_3,(rotavator × 2)	6.78	13.29	37.85	2131.33	6.78	69.56	6.78	119.06	2333.4	53.81	53.55	43.36	43.65
5.	T_4,(rotavator ×1)	3.30	6.47	18.10	1019.21	3.30	33.86	3.30	57.95	1117.49	52.87	52.43	21.14	21.31
	T_5, (zero tillage)	_	_s	_	_	_	_	_	_	_	56.01	55.87	_	_

5. CONCLUSIONS

After the observation of the results it concluded that the sugarcane planting under all tillage treatments with pre and post planting irrigation conditions give similar cane yield. Hence zero tillage has better prospects for sugarcane planting after wheat harvest. The zero tillage technique will not only same energy but also advanced planting time of sugarcane in wheat, sugarcane crop sequence.Planting obtained cane with disc and slit type cane planters gave better performance as compared to ridger type planter.

REFERENCES

[1] Anonymous.1977. Extending crushing season of sugar cane. Annual Report Indian Institute of Sugarcane Research . Lucknow. pp.11-13.

[2] Anonymous.1997. Indian J. Agron., Vol.42(4):pp.657-660, December,1997.

[3] Anonymous .1999. Indian sugar . The Indian Sugar Mills Association.XL:475-476.
[4] Anonymous.2001. Indian sugar . The Indian Sugar Mills Association.XLIX:222-224.
[5] Anonymous.2001. Productivity constraints. The Hindu Survey of Indian Agriculture. pp.97-102.
[6] Bachloo,S. 1984. Studies on planting and harvesting schedule of sugarcane varieties
[7] Bahri, A. and Bansal, R. K. 1992. Evaluation of different combination of openers and press wheels for no-till seedlings . In: Tillage in arid and semi-arid areas, Seminar on Agricultural Engineering, Rabat Morocco, April 22-25, 1992, (c.f.liter.upto date on wheat, 1995. Vol.1(3):pp.2270)
[8] Baker, C. J. 1983. Some developments in direct drilling equipment in New Zealand. Agric. Mech. in Africa and Latin America.Vol.14(4):pp.25-30.
[9] Baker, C.J.; McDonald, J.H.; Rix, C. S.; Seebeck, K. and Griffiths, P. M. 1979. Development with seed drill coulters for direct drilling an improved chisel coulter with trash handling and fertilizer placement capacities .N.Z.Jl.Res.Agric.,7:pp. 189-196.
[10] Barnes,P.L. and Maddux,L.D.1991. Tillage system effects on soil physical properties . American. soci. Agril. Engg., No. 91-2627, 19 p.
[11] Bernacki,H.;Haman, J. and Kanafojski, C.Z. 1972. Agriculture machines, theory and construction. National technical Information service, Warsaw: 203-205.
[12] Bhatt,V.K. and Pandey , M.C. 1982. Modification and testing of sugarcane planter. Unpublished, B. Tech. Dissertation, G.B. Pant University of Agriculture and Technology, Pantnagar , Uttaranchal .
[13] Black, C.A. 1971. Methods of soil analysis –Part 2. Am. soc. Agron. Inc. Publisher, Madison, Wisconsin. USA.
[14] Borin , M. and Sartori, L. 1995. Barley, soybean and maize production using ridge tillage, no –tillage and conventional tillage inn north east Italy. J. Agric. Engg. Res. 62:pp.229-236.
[15] Bouyoucos, G.j. 1972. Hydrometer method improved for making partical size analysis of soils. Agron., J. 54:pp.464-465.
[16] Brenner, J.M. and Mulvaney, C.S. 1982. Nitrogen total . In: Page, A.L.; Miller, R.H. and Kineey, Dr. (Eds) Methods of soil analysis part 2 American society of Agronomy, Inc. soil science Soc. America. Inc., Madison , Wisconsin, USA. pp. 595-624.
[17] Choudhary, A.d.: Baker, C.J, and Springett, J.A. 1990. Direct drilling (no- till) opener design specification and soil micro and environmental factors to influence barley seedlings establishment in a wet soil . In: International Congress on Mechanization and energy inn agric. Conference, Adana, Turkey at October 1-4, 1990. pp. 201-211.
[18] Choudhary, M.A. 1988. A new multi crop inverted- T seeder for upland crop establishment. AMA, Vol.19(3):pp.37-42
[19] Choudhary, M. A. and Baker, C. J. 1980. Physical effects of direct drilling equipment on undisturbed soil. Wheat seedlings emergence from a dry soil under controlled climates. N.Z. Jl. Agric. Res., 23:pp. 489-496.
[20] Choudhary, M. A. and Baker, C. J. 1981. physical effects of direct drilling equipment on undisturbed soil. Wheat seedlings performance and ingroove micro-environment in a dry soils. N. Z. Jl. Agric. Res., 24: pp.189-195.
[21] Choudhary, M. A. and Baker, C. J. 1982. Effect of direct drill coulter design and soil moisture status on emergence of wheat seedlings. Soil and Tillage Res., 2 :pp. 131-141.
[22] Deshpande, S.B.; Fahrenbacher, J. B. and Ray, B. W. 1971. Mollisols of Tarai region of Uttar Pradesh, Northern India. II. Genesis and classification. Geoderma, 6:pp.195-201.
[23] Ellis, F. B.; Elliott, J. g.; Pollard, F.; Cannel, R.Q. and Barneo, B.T. 1979. Comparison of direct drilling, reduced cultivation and ploughing on the growth of cercals, winter wheat and spring barley on calcareous soil. J. Agric. Sci.; 93:pp.391-401.
[24] El-Sharkawy, M. A. and Sgaier, k. 1975. Effect of tillage on root penetration and grain yield of maxi an wheat(triticum aestivum L.) grown in Libyan Desert. Libyan J. Agric., 4:20-28.
[25] Fashili, S. and Malik, K. 1974. Effect of sowing on the yield and quality different sugarcane varieties. Agric. Pakistan Vol.25(3):pp.151-158.
[26] Fink, J.T. and Currence, H. D. 1995. No- till drill utilizing adjustable seed furrow openers . appl. Engg. Agric., Vol.11(6): 811-816.
[27] Fyre, W. W. and Lindwall, C. W. 1986. Zero tillage Research priorities . Soil and tillage Research, 8:pp. 311-316.
[28] Gangwar, K. S. and Sharma, S. K. 1997. Simultaneous planting of sugarcane (saccharum officinarum) and wheat (triticum aestivum) for higher productivity and profitability of sugarcane –wheat system . Indian J. Agron.,Vol. 42(4):pp. 657-600.
[29] Gee-clough, .D.; McAlister, M. and Evernden, W. 1977. Tractive performance of tractor drive tires. I. The effect of lug height, J. Agric. Engg. Res., Vol.22(4): pp.373-384.
[30] Gupta, D. K. 1989. Soil management for wheat crop after paddy harvesting thesis, M. tech. G. B. Pant University of agriculture and technology, Panthnagar.
[31] Payton, D. M.; Hyde, G. M. and Simpson, J. B. 1985. Equipment and methods for no-tillage wheat planting. Trans ASAE.Vol. 28(5) :pp. 1419-1424, 1429.
[32] Shukla, L.N.; Sharma, M.P. and Verma, S.R. 1984. Development of a sugarcane planter for developing countries. Agric. Mech. In Asia, Africa and Latin America, Vol.15(1) : pp.33-42.

