Evaluating Effect of Irrigation, Planters and Conservation Tillage on Sugarcane Crop under NWPZ Conditions after Wheat Crop Harvest

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Abstract

A field experiment was conducted for two consecutive years (2014-15 to 2015-16) at Amroha district of Uttar Pradesh State, India. Different sugarcane planter and conservation tillage practices were tested for intensification and productivity of sugarcane (Saccharum officinarum L.) after wheat harvest in Fauladpur research farm of Amroha district in NWP region of Uttar Pradesh. With three replication with different trials, the results of the experiment revealed that the ridger type sugarcane cutter planter showed the highest value in treatment effect of the planters on average sett length (32.69 cm). The lowest value in treatment effect of the ridger type sugarcane cutter planter was average percentage damage buds (4.85 %), average percentage overlapping of setts (31.68 %) and average percentage missing (3.89 %).

Keywords
Sugarcane, Irrigation, Tillage, Planters, Ridger, Slit, Yield

Introduction

Sugarcane is a worldwide crop cultivated in 105 countries. Sugarcane has played an important role to improving socioeconomic status of human life from its ancient production to modern day’s status.

Sugarcane was mostly utilized as a crop for the purpose of food production of sugar, Jaggery or bura, shakkar and other form of sweetener. For the purpose of maximize the production of sugarcane from per unit area field and highest production of sugar from the sugar factories, researchers have been practices many improved cane varieties and production techniques. Sugarcane has a great economical importance for a farmer due to its versatile nature. Sugarcane is important crop for sugar because it contributes about 64.6% of sugar production.

Sugarcane (Saccharum officinarum L.) is an important food cum cash crop and cultivated between 32°N to 32°S latitude covering more than 90 countries of the world (Kumar et al., 2017a; Kumar and Tripathi, 2017c). Sugarcane occupies a very prominent position
on the agricultural map of India covering astronomically immense areas in sub-tropics and tropics (Kumar et al., 2017b).

India is one of the highest producers of sweetener (sugar) and it has a tough competition with Brazil for the first rank. The India has shared about 13.25% of the World’s and about 41.11% of Asian sugar production and sugarcane is cultivated in about 4.10mn hectares with the yearly production of about 300.25mn tons of sugarcane and 18.90mn tons of sugar. In India the major area under this crop presented in subtropical belt covering Uttar Pradesh, Bihar, Punjab, Uttarakhand, Haryana, Rajasthan and Madhya Pradesh; which used about 70% of the cane cultivated area and 50% of the sugarcane production. Sugarcane cultivated highly in Uttar Pradesh and Uttarakhand states which is jointly make 49.74% of the total cane area and about 44.34% of the total cane production in country.

Planting of sugarcane carried a number of operations such as cutting of canes into setts, tillage, furrows opening, use of fertilizer in the furrows, inserting setts and covering these open furrows with a blanket of soil. To suit the varying agro climatic conditions of different states, these operations are sometimes changed and modified and are performed either manually with help of animal drawn or tractor drawn ridge and sugarcane sets are placed and covered manually or by machinery. Thereafter, wooden planked is used to ensure better sett and soil moisture content.

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. By using tractor-drawn sugarcane cutter planter, the economising labour and energy could be reduced. Planting of sugarcane is performed by cuttings setts from a mature plant of sugarcane, rather than from its seed. Although certain types of sugarcane varieties are still producing from the seeds, but the present methods of stem cuttings of mature sugarcane have become the most common method of reproduction of sugarcane. For this purpose, each cutting has at least one bud. There are various methods of the planting of sugarcane such as flat type, trench type, pit type, staggered row and spaced transplanting methods. Farm mechanization of sugarcane production is an essential thing to the modern agriculture, as it enhances better productivity, besides reducing human drudgery and cost of cultivation. Since, the cost of harvesting of sugarcane by mechanized process is almost one third of complete manual process. Thus cane cutter planters are getting good response by the farmers, due to the reduction of unit operations and man power (Kumar et al., 2015).

Planting of any crops creates the ground for it and plays an important role in its production. It is planted in the form of cut setts of 2–3 buds. For preparing setts, manually operated hand tools and power operated sett-cutting machines are used. Tractor operated rotary plough, cultivator and ridger are the main farm equipments, used for tillage and ridge forming operations in sugarcane cultivation.

In the present era of labour shortage and unavailability of animal to do farm operations, there is an urgent need to mechanize sugarcane planting for reducing the cost as well as the human drudgery involved. Under conventional method, the sugarcane sett cutting process is a pre planting practice, while in mechanized system setts cutting is done simultaneously by the planter. This ultimately reduces time, labour and moisture loss in setts of cane and helps in higher germination percentage. Thus to reduce
drudgery and cost of planting, efficient utilization of seed and fertilizer, use of planters is advocated.

Materials and Methods

A field experiment was conducted for two consecutive years (2014-15 to 2015-16) at Amroha district of Uttar Pradesh State, India. Different sugarcane planter and conservation tillage practices were tested for intensification and productivity of sugarcane (*Saccharum officinarum* L.) after wheat harvest in Fauladpur research farm of Amroha district in NWP region of Uttar Pradesh. There were two irrigations, pre-planting irrigation (*I*₁) and post-planting irrigation (*I*₂), four planters as Disc type sugarcane cutter planter (*P*₁), Slit type sugarcane cutter planter (*P*₂), Ridger sugarcane cutter planter (*P*₃) and Furrower type sugarcane cutter planter (*P*₄) and control (*P*₀) as conventional practice, two tillage as *(T*₁) Conventional tillage (1 ploughing + 2 harrowing) and *(T*₂) Tillage operation by rotary tiller (2 rotavator) (*T*₂) were tested under RBD (Factorial 2 x 5 x 2) with three replications. The control was the conventional practices of sugarcane planting (furrow opening by the tractor operated ridger and then manual sett placement in the furrows) as prevailing in the district. The plot size was 10 m x 8 m and sugarcane variety was CoS-767. The different machine performance and crop parameters were taken during the field operations which are discussed below:

**Average sett length (cm)**

**Average percentage damage buds**

This was determined by the dividing the total average number of damaged buds by the total average number of buds in five meter.

\[
\text{Average damaged buds} (\%) = \frac{\text{Average number of damaged buds in 5m}}{\text{Average number of the buds in 5m}} \times 100
\]

**Average percentage overlapping of setts**

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

\[
\text{Percentage overlapping} = \frac{l_s - l_p}{l_p} \times 100
\]

Where,

\( l_s = \text{Total sett length in 5 m planted distance, cm} \)

\( l_p = \text{Observed distance in 5 m} \)

**Average percentage missing**

The unplanted distance observed during planting was measured in 5m length. The percentage missing area was determined by the following relationship:

\[
\text{Percent missing area} = \frac{\text{Unplanted distance in 5m}}{5m} \times 100
\]

**Results and Discussion**

**Effect of irrigation**

Results of the experiment from Table 1 revealed that non significantly the highest value was observed in treatment effect of the irrigation on the *viz.*, that average sett length (30.92 and 31.07 cm) at 2014-15 and 2015-16, average percentage damage buds, average percentage overlapping of setts (28.43) at second year and average percentage missing (3.23) at second year in treatment, respectively (*I*₁) Pre-planting irrigation. However, non significantly the highest value of average percentage damage buds (4.29 and 4.35) during 2014-15 and 2015-15, average percentage overlapping of setts (28.37) and average percentage missing (3.28) at first year in treatment, respectively in (*I*₂) Post-planting irrigation.
Table 1: Response of irrigation, planters and tillage on average sett length (cm), average percentage damage buds, average percentage overlapping of setts and average percentage missing of sugarcane

| Treatments | Average sett length (cm) | Average percentage damage buds | Average percentage overlapping of setts | Average percentage missing |
|------------|--------------------------|--------------------------------|----------------------------------------|---------------------------|
|            | 2014-15      | 2015-16 | 2014-15      | 2015-16 | 2014-15 | 2015-16 | 2014-15 | 2015-16 |
| Irrigations (I) |                     |        |              |          |          |          |          |          |
| I₁         |              |         |              |          |          |          |          |          |
| Pre-planting irrigation | 30.92 | 31.07 | 4.22 | 4.16 | 28.12 | 28.43 | 3.19 | 3.23 |
| I₂         |              |         |              |          |          |          |          |          |
| Post-planting irrigation | 30.58 | 30.63 | 4.29 | 4.35 | 28.37 | 28.14 | 3.28 | 3.14 |
| F-test     | NS          | NS      | NS          | NS | NS | NS | NS | NS |
| S. Ed. (±) | 2.64 | 2.47 | 0.74 | 0.78 | 2.19 | 2.18 | 0.60 | 0.64 |
| C. D. (P = 0.05) | - | - | - | - | - | - | - | - |
| Planters (P) |                     |        |              |          |          |          |          |          |
| P₀         |              |         |              |          |          |          |          |          |
| Conventional practice (Tractor operated ridger) (control) | 24.64 | 25.66 | 1.55 | 1.61 | 11.79 | 11.39 | 0.00 | 0.00 |
| P₁         |              |         |              |          |          |          |          |          |
| Disc type sugarcane cutter planter | 31.99 | 31.63 | 4.97 | 4.95 | 32.54 | 32.32 | 4.01 | 3.98 |
| P₂         |              |         |              |          |          |          |          |          |
| Slit type sugarcane cutter planter | 32.15 | 32.39 | 4.86 | 4.89 | 32.42 | 32.32 | 4.18 | 4.12 |
| P₃         |              |         |              |          |          |          |          |          |
| Ridger sugarcane cutter planter | 32.69 | 32.46 | 4.93 | 4.85 | 31.68 | 32.35 | 4.00 | 3.89 |
| P₄         |              |         |              |          |          |          |          |          |
| Furrower sugarcane cutter planter | 32.27 | 32.09 | 4.97 | 4.96 | 32.79 | 33.04 | 3.98 | 3.95 |
| F-test     | S           | S       | S           | S | S | S | S | S |
| S. Ed. (±) | 1.27 | 1.56 | 0.47 | 0.49 | 1.39 | 1.38 | 0.38 | 0.40 |
| C. D. (P = 0.05) | 4.78 | 4.47 | 1.34 | 1.42 | 3.97 | 3.94 | 1.09 | 1.15 |
| Tillage (T) |                     |        |              |          |          |          |          |          |
| T₁         |              |         |              |          |          |          |          |          |
| Conventional tillage (1ploughing + 2 harrowing) | 30.83 | 30.91 | 4.24 | 4.20 | 28.10 | 28.38 | 3.15 | 3.17 |
| T₂         |              |         |              |          |          |          |          |          |
| Tillage operation by rotary tiller(2 rotavator) | 30.67 | 30.79 | 4.27 | 4.31 | 28.39 | 28.19 | 3.32 | 3.20 |
| F-test     | NS          | NS      | NS          | NS | NS | NS | NS | NS |
| S. Ed. (±) | 2.64 | 2.47 | 0.74 | 0.78 | 2.19 | 2.18 | 0.60 | 0.64 |
| C. D. (P = 0.05) | - | - | - | - | - | - | - | - |
| Interaction (PxI) |                   |        |              |          |          |          |          |          |
| F-test     | NS          | NS      | NS          | NS | NS | NS | S | NS |
| S. Ed. (±) | 1.18 | 1.10 | 0.33 | 0.35 | 0.98 | 0.97 | 0.27 | 0.28 |
| C. D. (P = 0.05) | - | - | - | - | - | - | 0.77 | - |
| Interaction (PxT) |                   |        |              |          |          |          |          |          |
| F-test     | NS          | NS      | NS          | NS | NS | NS | S | S |
| S. Ed. (±) | 1.45 | 1.35 | 0.41 | 0.43 | 1.20 | 1.19 | 0.33 | 0.35 |
| C. D. (P = 0.05) | - | - | - | - | - | - | 0.95 | 1.00 |
| Interaction (IxT) |                   |        |              |          |          |          |          |          |
| F-test     | S           | S       | S           | S | S | S | S | S |
| S. Ed. (±) | 1.87 | 1.75 | 0.50 | 0.55 | 1.55 | 1.54 | 0.43 | 0.45 |
| C. D. (P = 0.05) | 5.35 | 5.00 | 1.50 | 1.58 | 4.44 | 4.41 | 1.22 | 1.29 |
Table 2 Interaction effect of irrigation, planters and tillage on average sett length (cm), average percentage damage buds, average percentage overlapping of sets and average percentage missing of sugarcane

| Treatments | Average sett length (cm) | Average percentage damage buds | Average percentage overlapping of sets | Average percentage missing |
|------------|--------------------------|--------------------------------|----------------------------------------|---------------------------|
|            | 2014-15 | 2015-16 | 2014-15 | 2015-16 | 2014-15 | 2015-16 | 2014-15 | 2015-16 |
| T1         | I1P0T1 | 25.10 | 26.03 | 1.65 | 1.26 | 11.53 | 12.00 | 0.00 | 0.00 |
| T2         | I1P0T2 | 25.13 | 26.13 | 1.38 | 1.47 | 11.20 | 11.13 | 0.00 | 0.00 |
| T3         | I1P1T1 | 32.20 | 31.47 | 4.98 | 4.97 | 32.23 | 31.93 | 4.00 | 4.01 |
| T4         | I1P1T2 | 31.83 | 31.83 | 4.93 | 4.90 | 33.37 | 32.77 | 4.17 | 4.17 |
| T5         | I1P2T1 | 31.03 | 31.97 | 4.87 | 4.87 | 33.07 | 32.73 | 3.82 | 3.82 |
| T6         | I1P2T2 | 33.23 | 33.23 | 4.75 | 4.88 | 32.27 | 32.20 | 4.62 | 4.62 |
| T7         | I1P3T1 | 34.13 | 33.47 | 4.65 | 4.32 | 29.90 | 32.92 | 3.30 | 3.80 |
| T8         | I1P3T2 | 31.97 | 31.95 | 4.99 | 4.99 | 31.83 | 31.83 | 3.97 | 3.97 |
| T9         | I1P4T1 | 31.93 | 31.93 | 5.08 | 5.08 | 33.38 | 34.37 | 4.16 | 4.17 |
| T10        | I1P4T2 | 32.63 | 32.63 | 4.90 | 4.87 | 32.43 | 32.43 | 3.85 | 3.77 |
| T11        | I2P0T1 | 24.83 | 25.17 | 1.62 | 1.87 | 12.20 | 11.53 | 0.00 | 0.00 |
| T12        | I2P0T2 | 23.50 | 25.30 | 1.55 | 1.85 | 12.23 | 10.90 | 0.00 | 0.00 |
| T13        | I2P1T1 | 31.73 | 31.73 | 4.98 | 4.98 | 31.80 | 31.80 | 3.82 | 3.68 |
| T14        | I2P1T2 | 32.20 | 31.48 | 4.98 | 4.96 | 32.77 | 32.77 | 4.05 | 4.05 |
| T15        | I2P2T1 | 32.50 | 32.50 | 4.73 | 4.73 | 31.80 | 31.82 | 4.01 | 4.00 |
| T16        | I2P2T2 | 31.83 | 31.87 | 5.08 | 5.08 | 32.53 | 32.53 | 4.27 | 4.03 |
| T17        | I2P3T1 | 32.49 | 32.48 | 4.92 | 4.92 | 32.76 | 32.42 | 4.18 | 4.03 |
| T18        | I2P3T2 | 32.18 | 31.94 | 5.17 | 5.17 | 32.24 | 32.23 | 4.55 | 3.75 |
| T19        | I2P4T1 | 32.30 | 32.30 | 4.95 | 4.95 | 32.30 | 32.30 | 4.20 | 4.18 |
| T20        | I2P4T2 | 32.20 | 31.49 | 4.95 | 4.94 | 33.05 | 33.07 | 3.69 | 3.69 |

Interaction (PxIxT)

| F-test | NS | NS | NS | NS | S | NS | S | S |
|--------|----|----|----|----|---|----|---|---|
| S. Ed. (±) | 0.84 | 0.78 | 0.23 | 0.25 | 0.69 | 0.69 | 0.19 | 0.20 |
| C. D. (P = 0.05) | - | - | - | - | 1.99 | - | 0.55 | 0.58 |
Effect of planters

A perusal of the Table 1 indicates that average sett length (cm) did differ significantly among the planters during both years. The higher value was observed as (32.69 and 32.46) in treatment (P3) Ridger sugarcane cutter planter for years 2014-15 and 2015-16 respectively.

A perusal of the table also shows that average percentage damage buds (4.97 and 4.96) and average percentage overlapping of setts (32.79 and 33.04) did differ significantly higher the treatment in planters (P3) Furrower sugarcane cutter planter for the years 2014-15 and 2015-16 respectively. While, in planters significantly higher value of average percentage missing (4.18 and 4.12) during 2014-15 and 2015-16 in treatment (P2) slit type sugarcane cutter planter respectively. This may be due to sugarcane coming directly in contact with blade center. In this design, cutting was smooth as evident from clean cut obtained. However, feeding rate was labour dependent, which may have caused variation in length of setts. With the advent of sugarcane cutter planters on the scene, where cutting of whole cane into setts is also done simultaneously, planting through machine has become a viable proposition. Slit, ridger type, disc and furrower type sugarcane cutter planters have been developed and successfully tested and demonstrated in the farmer’s fields (Singh and Singh 2006).

Effect of tillage

The results indicated from Table 1 revealed that non significantly the maximum value was observed in treatment effect of the tillage on the viz., average sett length (30.83 and 30.91 cm) during both of the years and average percentage overlapping of setts (28.8) during 2015-16 in treatment (T1) Conventional tillage (1 ploughing + 2 harrowing) respectively. However, non significantly the maximum value average percentage damage buds (4.27 and 4.31) during both of the years, average percentage damage buds (28.39) at 2015-16 and average percentage missing (3.32 and 3.20) during in both of the years in treatment, (T2) Tillage operation by rotary tiller (2 rotavator) respectively.

Interaction effect

A perusal of the data from Table 1 and 2 on average sett length (cm), average percentage damage buds and average percentage overlapping of setts non-significantly during both years by interaction effect of planters with irrigation (PxI) and planters with tillage (PxT) and significantly the highest in interaction of irrigation and tillage (IxT). However, average percentage missing significantly higher during both years by interaction effect of planters with irrigation (PxT) and planters with tillage (IxT). It is also clear that from the data which found interaction effect of planters with irrigation and tillage (PxIxT) in both years. The highest value found viz., average percentage missing (4.62 and 4.62), treatment (T6) I1P3T2 Pre-planting irrigation + Slit type sugarcane cutter planter + Tillage operation by rotary tiller (2 rotavator) during the years 2014-15 and 2015-16, respectively.

However, average sett length (34.13 and 33.47 cm) during both of the year in treatment I1P3T1 (T7) Pre-planting irrigation + Ridger sugarcane cutter planter + Conventional tillage (1 ploughing + 2 harrowing), average percentage damage buds (5.17 and 5.17) during both of the year in treatment I2P3T2 (T18) Post-planting irrigation + Ridger sugarcane cutter planter + Tillage operation by rotary tiller (2 rotavator), and average percentage overlapping of setts (33.38 and 34.37) during both of the year in treatment...
I_{P_{1}}T_{1}\, (T_{18})\, Pre-\, planting\, irrigation\, +\, Furrower\, sugarcane\, cutter\, planter\, +\, Conventional\, tillage\, (1ploughing\, +\, 2 harrowing),\, respectively.

After\, the\, analysis\, of\, the\, different\, treatment\, of\, the\, sugarcane\, production\, with\, the\, consideration\, of\, two\, irrigation\, planting\, field conditions\, (pre and post-\, planting\, irrigation),\, two\, tillage\, (Conventional\, tillage\, (1ploughing\, +\, 2\, harrowing)\, and\, Tillage\, operation\, by\, rotary\, tiller\, (2\, rotavator))\, and\, one\, conventional\, and\, four\, sugarcane\, cutter\, planters\, for\, two\, years.\, The\, minimum\, treatment\, effect\, of\, the\, average\, percentage\, damage\, buds,\, average\, percentage\, overlapping\, of\, setts\, and\, average\, percentage\, missing\, of\, sugarcane\, in\, the\, Ridger\, sugarcane\, cutter\, planter\, was\, found\, during\, the\, years\, in\, comparison\, of\, the\, other\, planters\, and\, it\, was\, (4.85,31.68\, and\, 3.89\, %)\, respectively.\, Maximum\, treatment\, effect\, of\, the\, average\, sett\, length\, was\, found\, (32.69\, and\, 32.46\, cm)\, during\, both\, year\, 2014-15\, and\, 2015-16\, respectively\, for\, Ridger\, sugarcane\, cutter\, planter.

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