Assessment of Method and application schedule of fertilizer N and K on growth and productivity of summer planted sugarcane crop (*Saccharum officinarum* L.) under wide spacing.

1. Abstract:

Present investigation was carried out at Regional Research Station, Uchani (Karnal) of CCS Haryana Agricultural University, Hisar, India during 2020-21 to assess the effect of method and schedule of fertilizer application ongrowth, yield attributes and cane yield of summer planted sugarcane (*Saccharum officinarum* L.)crop under wide spacing(120 cm). The experiment wasarranged in split plot design with two methods of fertilizer application (B1-broadcasting and B2- band placement) as main plot treatments and four sub plot treatments which include application of recommended dose of N and K fertilizer (RDF) in different number of splits at different no. of days after planting (DAP) *i.e.* T1(five splits), T2(six splits), T3(seven splits) and T4(three splits). Results concluded thatmajority of growth parameters, yield attributes and cane yield were significantly affected by both main and sub plot treatments at different stages of crop growth period.Treatment B2 registered significantly higher tiller population (110.59 and102.68 000 ha^{-1} at 60 and 120 DAP respectively), plant height (91.16, 141.18, 400.12 and 412.13 cm at 60, 120, 180 and 240 DAP respectively), no. of millable canes (NMC)(100.79 and 96.58 000 ha^{-1} in mid-September and at harvesting respectively) cane length (234.64 cm at harvesting) and cane yield (93.16 t ha^{-1})compared to B1. Among sub plot treatments, T1 outperformed all the other treatments in terms of growth, yield attributes and cane yield. Treatment T1 registered maximum plant height (150.43, 411.0 and 427.45 cm at 120, 180 and 240 DAP respectively), tiller population (104.72 000 ha^{-1} at 120 DAP),NMC (102.06 and 95.20 000 ha^{-1} in mid-September and at harvesting respectively)and cane yield (94.83 t ha^{-1}). Germination percentage, cane girth, no. of internodes per cane and length of internodes was not significantly affected either by main or sub plot treatments.

Key words: Split application, Band Placement, Broadcasting, Cane yield, Growth

2. Introduction:

Sugarcane (*Saccharum officinarum*) is a widely cultivated commercial crop in the world with distribution spanning in more than 109 countries covering 26.9 million hectares (M ha) area worldwide. It is the most preferred field crops of tropical areas (Thorburn *et al.*, 2011) owing to its ability to grow on a variety of soils which can retain moistureunder hot and humid climate as a prerequisite. A memberof the Gramineae family with New Guinea credited as its centre of origin,*Saccharum officinarum* and its hybrids contributes to 70% of the sugar produced globally. It is a principal cash crop of India and employs about one million people directly or indirectly. More than 45 million sugarcane growers in India, and about 65 % of the rural population depend on this agro-based industry (Dotaniya *et al*., 2016).It provides significant supports to the national economy through the export of its processed products especially white sugar.

Brazil was the largest producer of sugarcane in world in 2018 producing of 758.5 million tons of total sugarcane followed by India which produced 306.1 million tons. In terms of area harvested in 2017 again Brazil stood at top spot with an area of 10.1 million hectares followed by India which occupies an area of 4.3 million hectares under sugarcane crop (FAOSTAT, 2019). In India, Uttar Pradesh has highest area under sugarcane cultivation. As of 2017-18, it covers approximately 0.11 million hectares of area in Haryana while the average production stood at 8.72 million tonnes in same year. Average productivity of sugarcane has been estimated to be 76.6 t ha^{-1} in 2015-16 which has surpassed the national average (Anonymus,2018).

Sugarcane is a long-duration, exhaustive crop and requires high amounts of macro as well as micro-plant nutrients (Paul *et al.,* 2005). It is known as heavy feeder and to produce 100 t of biomass from 1 ha, it depletes 140, 34 and 332 kg of N, P and K ha^{-1}, respectively, from soil (Bokhtiar *et al.*, 2001). Chemical fertilizers are among the crucial inputs to satisfy nutrient requirement of crops for obtaining high yield in modern crop production. High requirement of plant nutrient limits the crop yield due to scarcity of fertilizers (Gholve *et al.*, 2001). Similarly, spiralling prices along with a short availability of fertilizers in peak season (Khandagave, 2003) cause depletion of plant nutrients from the soil (Ibrahim *et al.*, 2008; Sarwar *et al*., 2008). Therefore, appraisal in the productivity demands adoption of effective nutrient management techniques to satisfy crop nutritional demand during the active growth stages. 4R nutrient stewardship approach may serve as a guide for the effective implementation of these techniques. The concept of this approach is based on application of right source of nutrient at right rate and time and in the right place. Suitable methods of fertilizer application determines the productivity of crop to a great extent by employing judicious use of available resources like nutrients, sunlight, water etc. Row spacing along with planting method accounts for most critical yield contributing factors in sugarcane (Ullah *et al.*, 2016).

The most common practice of applying fertilizers in sugarcane is broadcasting which utilizes only 20-30% of P andK, and 40–50% of N. Placement of fertilizer in bands enhances the concentration of nutrients in specific zones which lowers the risk of fixation in case of P and K and volatilization and leaching losses of N thereby increases their availability to the plants. For maximum efficiency of applied fertilizer, it is essential to direct the flow of nutrients to the roots ofthe plants at a rate which is sufficient for maximum uptake (Mandal and Thakur, 2010).Along with method of fertilizer application, timing of delivering of N fertilizer to plants is also the most critical factor which determines the final yield. A judicious N application is of paramount importance for high production. Deficiency of this nutrient in the agro-ecosystem frequently reduces crop growth and yield (Hawkesford, 2011). Nitrogen management for sugarcane enhances plant height, stem diameter, and the number of tillers, parameters that are closely related to crop yield. Maximizing the availability of N during the active growth period of crop by establishing a synchrony between crop nutrition demand and supply enhances the chances of improving yield (Otto *et al*., 2020). The present study aims to explore the role of both timing and method of fertilizer application in developing effective precision nutrient management strategies.

3. Materials and Methodology:

3.1.Experimental Site and Climate

Field experiment was conducted at Regional Research Station, CCS Haryana Agricultural University, Karnal located at latitude of 29°43'42.19" N and longitude of 76°58'49.88" E and at an altitude of 253 meters above mean sea level. It is roughly equidistant and almost midway from New Delhi and Chandigarh.

The climate is sub-tropical with mean maximum temperature ranging between 34-39 °C in summer and mean minimum temperature ranging between 6-7 °C in winter. Most of the rainfall is received during the months of July to September and few showers during December to late spring.

3.2 Soil of Experimental Plot

The field at Regional Research Station, CCSHAU, Karnal selected for conducting the experiment was uniform in fertility gradient. Initial soil fertility status of experimental field was determined prior to planting of crop, for which four representative soil samples were collected randomly from the entire field at a depth of 0-30 cm before implementing the final layout of experiment. The analysis was carried out by strictly following established protocols and standard procedures. From the interpretation of results obtained after soil analysis, it was interpreted that soil exhibited clay loam texture, alkaline in reaction, medium in OC content, low in available N and medium in P and K content.

3.3 Treatments and Layout of the Experiment:

The experiment was arranged in Split Plot Design with three replications. The experiment was designed with two main plots (Mode of fertilizer application *i.e.* Broadcasting and Band Placement) and four sub-plots (No. of split application i.e. 5, 6, 7 and 3 splits). The details of experiment are given below:

3.4 Treatment Details:

3.4.1 Main plot treatments (two): Methods of fertilizer application

B1: Broadcasting

B2: Band placement

3.4.2 Sub Plot treatments (four): Number of splits of recommended dose of fertilizer:

T1	Recommended dose of N and K in five splits (Basal 10% and remaining dose at 45, 75, 90 and 120 DAP)
T2	Recommended dose of N and K in six splits (Basal 10% and remaining dose at 45, 75, 90, 120 and 150 DAP)
T3	Recommended dose of N and K in seven splits (Basal 10% and remaining dose at 45, 75, 90, 120, 150 and 180 DAP)
T4	Recommended dose and schedule of nutrient applications (Half of total N and full dose of P and K at planting and rest of the N at 45 and 90 DAP)

3.5 Plant growth parameters

The values of following growth parameter were recorded at different stages of crop growth according to schedule to test the influence of different treatments on crop growth and development.

3.5 Germination percentage (%)

Each set used for planting contained two matured buds. Number of buds germinated was counted at 30 and 45 days after planting and the germination percentage was determined by dividing the total number of buds germinated per plot and total number of buds planted per plot.

$$\text{Germination percentage (\%)} = \frac{\text{Total number of buds germinated per plot}}{\text{Total number of buds planted per plot}} \times 100$$

3.5.3 Plant Height (cm)

Plant height in a plot was recorded by taking the average of heights of five randomly selected plants, one in each row except in 1^{st} and last row to avoid any border effect. The height of each selected plant was measured from base to tip of the plant. The observations for plant height were recorded at 60, 120, 180 and 240 DAT.

3.5.2 Number of Tillers (000 ha^{-1})

Tiller population was recorded by counting total number of tillers per plot and then it was converted into 000' ha^{-1} using the following formula:

$$\text{Number of tillers (000 ha}^{-1}\text{)} = \frac{\text{Number of tillers per plot}}{\text{Area of plot (m}^2\text{)}} \times 10$$

3.6 Yield attributes:

3.6.1 Number of Millable Canes (000 ha^{-1})

Number of millable canes (NMC) was recorded in September and at harvesting by counting the number of canes of more than 1 m length per plot and converted into NMC 000 ha^{-1} using the formula:

$$NMC\ (000\ ha^{-1}) = \frac{\text{Number of millable canes per plot}}{\text{Area of plot } (m^2)} \times 10$$

3.6.2 Cane girth (cm)

Cane girth of a plot was calculated by taking average of individual cane girths of five randomly selected canes at the time of harvesting. Cane girth of an individual cane was measured at two positions *i.e.*, bottom and top by using vernier's caliper and average of these two positions is taken as final girth of whole cane.

3.6.3 Number of Internodes per Cane

Five canes were randomly selected one from each a row except 1^{st} and last row in a plot to avoid border effect and number of internodes per each cane were calculated by counting number of internodes from base to top node of that respective cane. Their average is taken to represent number of internodes per cane per plot.

3.6.4 Length of Internodes (cm)

Length of an individual internode of a cane was calculated by dividing the cane length by number of internodes in that respective cane. The average of internodes lengths of five randomly selected canes each from a row except 1^{st} and last in a plot represents length of internodes of cane in that respective plot.

3.6.5 Single Cane Weight (kg)

Single cane weight in a plot was recorded by taking average weight of five randomly selected canes one from each plant row except 1^{st} and last row to nullify any border effect.

3.6.6. Cane Yield (t ha^{-1})

Cane yield was recorded by taking total weight of all the canes in a plot after stripping and removing immature internodes and then converting the cane yield obtained per plot using the formula mentioned below

$$\text{Cane yield } (t\ ha^{-1}) = \frac{\text{Cane yield in kg per plot}}{\text{Area of plot (m2)}} \times 10$$

3.7 Statistical analysis:

Statistical analysis was carried out by employing OPSTAT software tool developed by Dept. of Statistics, CCS Haryana Agricultural University. Critical Difference (CD) at 5% level of significance was worked out through two-way Analysis of Variance (ANOVA).

4.1 Effects of different treatments of fertilizer application on growth parameters

Sugarcane crop growth is predominantly represented by parameters including germination percentage, shoot population, plant height, number of tillers and dry matter accumulation.

4.1.1 Germination percentage

Germination of crop recorded at 30 and 45 DAP (Table 1) was not significantly influenced either by method of fertilizer application or number of splits of fertilizer applied which can be attributed to the non-critical role of soil nutrients for germination as reserved sucrose present in planted sets assumed the role root development as argued by Gana (2011).Among main plot treatments, slightly higher germination percentage (43.07 %) was registered in band placement method (B2) of fertilizer application than broadcast method (B1) in which 42.79 % germination was observed.

Among the number of splits, highest germination percentage (43.34 %) was observed in 5 splits (T1), followed by 7 splits (T3), 6 splits (T2) and 3 splits (T4) in which 42.99, 42.77 and 42.62 % germination was observed respectively.Similar trend was observed for the germination percent at 45 DAP. Although, variation was observed among all the treatments but the difference was statistically non-significant.Germination percent showed an increasing trend from 30 DAP till 45 DAP. These findings are consistent with the results obtained from similar studies conducted by Gana (2011).Moreover, germination depends on a number of factors as suggested by Nalawade *et al*. (2018), which comprise of climatic conditions, seed quality, health and rate, layout and spacing, bud position, soil moisture and temperature etc. which were similar for all the treatments resulting in almost uniform germination in all the treatments.

Table 1: Effect of different methods of fertilizer application and numbers of splits of N and K on germination percentage and shoot population of sugarcane crop

	Germination Percentage	
Method of fertilizer application	**30 DAP**	**45 DAP**
B1-Broadcasting	42.79	44.57
B2- Band Placement	43.07	46.05

SEm±	0.72	0.35
CD (p=0.05)	NS	NS
Number of splits of N and K		
T1-5splits	43.34	45.29
T2-6 splits	42.77	47.27
T3-7splits	42.99	44.49
T4-3splits	42.62	44.19
SEm±	0.44	1.39
CD (p=0.05)	NS	NS

The interaction between methods of fertilizer application and number of split doses was found to be non-significant.

The non-significant influence of the sub and main plot treatments on germination can be attributed to the non-critical role of soil nutrients for germination as reserved sucrose present in planted sets assumed the role root development.

4.1.2 Plant Height

Significantly higher growth in the height of plants under B2 at 60(91.16 cm), 120(141.18 cm), 180(400.12cm) and 240 (412.13 cm) days after tillering (DAT) was observed compared to that under B1. Placement of fertilizer in proximity of roots may have led to enhanced availability of added nutrients to plants under B2. Banding of fertilizers might also had prevented the fixation P and K and volatilization losses of N by reducing the soil-fertilizer contact to minimum and negligible exposure of fertilizer to surface which ultimately resulted in better uptake andaugmentation of plant height. Similar findings are also documented by Gana (2011),Choudhary *et al.*(2016), Prasertsak *et al.* (2002), and Rehim *et al.* (2016) in sugarcane.

Effect of application of fertilizer in different no. of splits on plant height of sugarcane crop was also evident from the dataTable 2. At 60 DAT, maximum plant height was recorded under T4(100.41 cm) can be attributed to application of higher amount of applied N initially in the first split of this treatment compared to others. This observation is in congruence with the findings of Tadesse (1993).T1 (94.38 cm)was statistically similar to T4.Maximum plant height at 120 (150.43 cm), 180 (411.0 cm) and 240 (427.25 cm)DAT was recorded under T1which might be due to development of synchrony between plant nutritional needs and its higher availability as a result of split application of fertilizer. This increased the number of internodes and length of internodes while at the same time each split of T1 contained more fertilizer than the splits of T2 and T3. Similar observations were made by Wubale and Girma (2018) and Sime (2013). Moreover, the whole amount of fertilizer in T1 was disbursed during the active growth period of crop (before 135 DAP)resulting in its effective utilization. Application of remaining splits of fertilizer at grand growth stage in T2 and T3 at 150 and 180 DAP were not efficiently used by crop. These findings are in corroboration with those of Esther (2016).

Minimum plant height was observed by T4 at 120 (126.28 cm), 180 (379.03 cm) and 240 (382.73 cm) DAT.Maximum expansion in plant height was between 120 and 180 DAT. The interaction effect was found non- significant between methods of fertilizer application and number of splits at all growth stages

Table 2: Effect of different methods of fertilizer application and numbers of splits of N and K on plant height of sugarcane crop

Methods of fertilizer application	**Plant Height (cm)**			
	60 DAT	**120 DAT**	**180 DAT**	**240 DAT**
B1- Broadcasting	87.75	133.49	389.27	400.16
B2- Band Placement	91.16	141.18	400.12	412.13
SEm±	0.13	0.83	1.02	1.54
CD (p=0.05)	0.90	5.48	6.69	10.08
Number of splits of N and K				
T1-5 splits	94.38	150.43	411.0	427.45
T2-6 splits	83.28	137.46	397.01	410.73
T3 -7splits	79.76	135.16	391.75	403.68
T4-3 splits	100.41	126.28	379.03	382.73
SEm±	2.60	2.46	2.34	2.94
CD (p=0.05)	8.12	7.66	7.301	9.17

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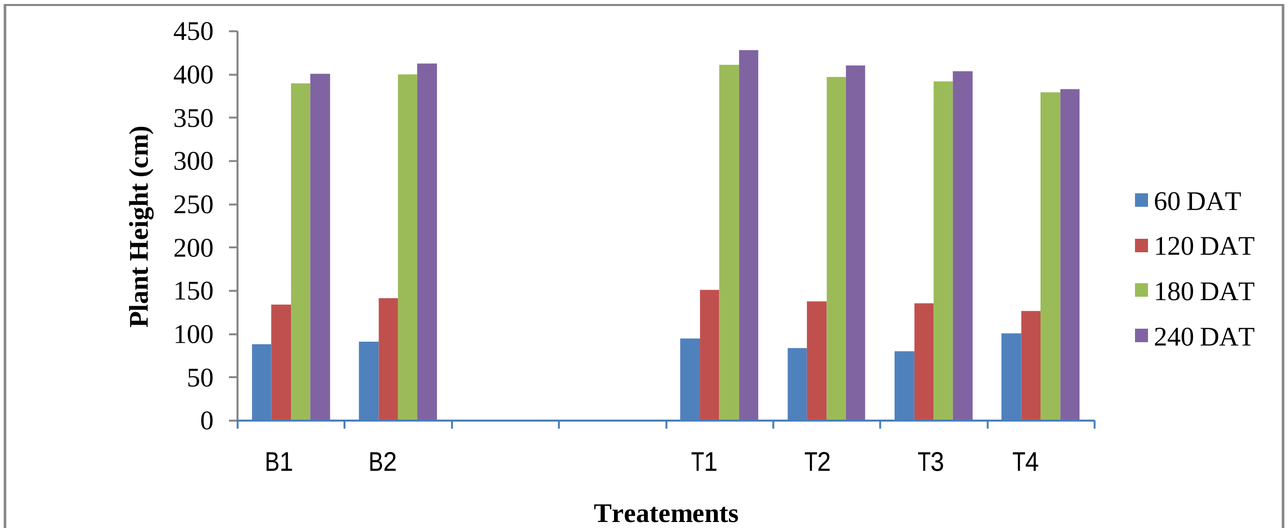
Fig 1: Effect of different methods of fertilizer application and numbers of splits of N and K on plant height of sugarcane crop



4.1.3 Number of tillers

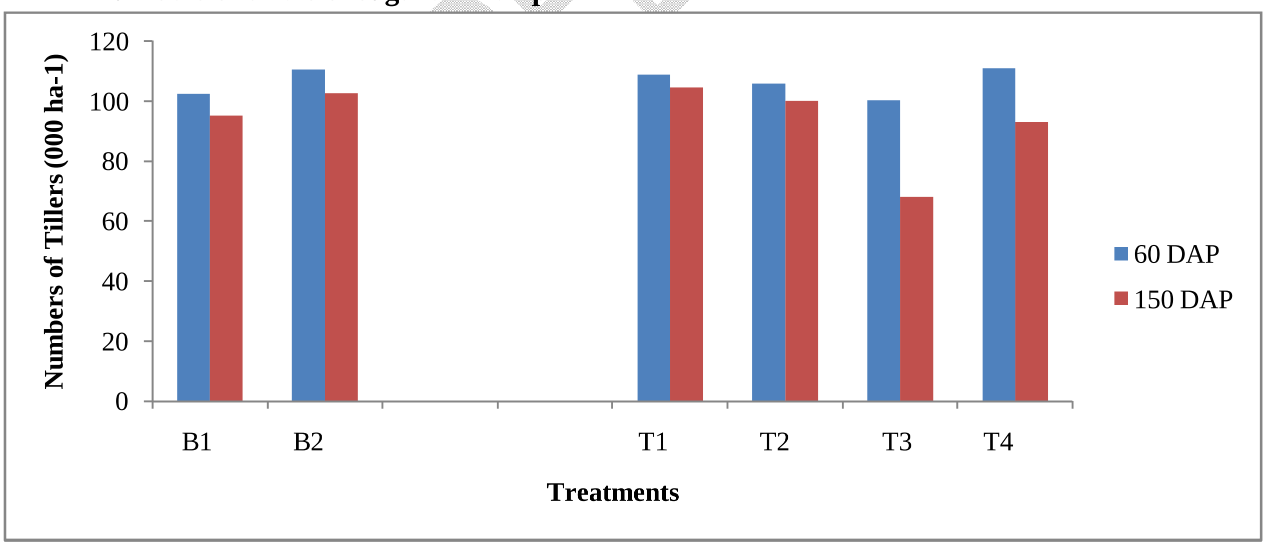
Ttiller population was significantly influencedboth under main plot and sub plot treatments (Table 3)Tiller population under B2 at 60 (110.59 000 ha^{-1}) and 150 DAP (102.68 000 ha^{-1}) was remarkably higher than B1 due to vigorous root growth because of abundant supply of N, P and K from the nearby fertilizer granules applied in bands close to plant rows assuggested by Gana (2011) and Rehim *et al.* (2012).Although total number of tillers decreased from 102.54 to 95.25 000 ha^{-1} in B1 and 110.59 to 102.68 000 ha^{-1} in B2during crop growth period between 60 to 150 DAP.

Among the sub plot treatments significant higher tiller population was registered under T4 (111.10 000 ha^{-1}) at 60 DAP compared to all other treatments except T1 which was at par with T4. Significantly lower tiller population (100.44 000 ha^{-1}) was recorded under T3 compared to all other treatments. At 150 DAP, significantly higher tiller population (104.72 000 ha^{-1}) was observed under T1compared to all other treatments and lowest tiller population (93.00 000 ha^{-1}) was recorded under T4. T2 and T3 were at par with each other.Higher tiller count at 60 DAP in T4 might be due to higher supply of N and K as it received more than half of RDF in first two splits before 60 DAP compared to other treatments while maximum tiller population in T1 at 150 DAP may be due the reason that in this treatment crop received whole RDF during active growth stage upto 120 DAP in different splits which coincided with its growth requirements and its proper utilization resulted in higher vegetative growth and tiller count (Sreewarome *et al.* 2007; Choudhary *et al.*, 2016).

Table 3: Effect of different methods of fertilizer application and numbers of splits of N and K on numbers of tillers of sugarcane crop

Methods of fertilizer application	Number of tillers (000 ha^{-1})	
	60 DAP	**150 DAP**
B1- Broadcasting	102.54	95.25
B2- Band Placement	110.59	102.68
SEm±	0.73	0.61
CD (p=0.05)	4.75	4.03
Number of splits of N and K		
T1-5 splits	108.80	104.72
T2-6splits	105.93	100.11
T3-7 splits	100.44	98.05
T4-3 splits	111.10	93.00
SEm±	0.90	0.80
CD (p=0.05)	2.83	2.51

Fig 2: Effect of different methods of fertilizer application and numbers of splits of N and K on numbers of tillers of sugarcane crop



4.2 Effects of different treatments of fertilizer application on yield attributes and yield

4.2.1 Number of Millable Canes

Number of millable canes (NMC) is one of the most decisive characters responsible for sugarcane yield and was highly influenced by both main and sub plot treatments.Significantly higher NMC were produced under B2in mid September (100.79000 ha^{-1})and at the time of harvesting (96.58 000 ha^{-1})compared to B1 (Table 4)which can be ascribed to reduced losses of applied N though ammonia volatilization thereby allowing the assimilation of larger portion of N fertilizer which resulted in improved cane population (Madhu *et al*., 2018; Choudhary *etal*., 2016; Prasertsak *et al*., 2002).

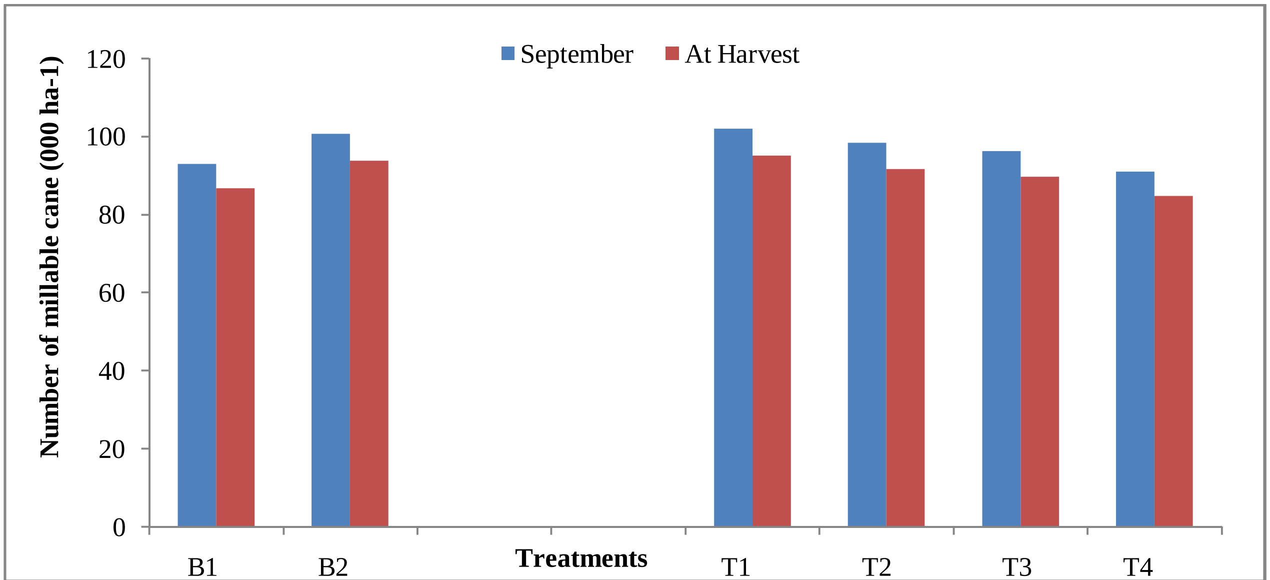
Among sub plot treatments, T1 produced significantly higher NMC mid-September(102.06 000 ha^{-1}) and at harvesting(95.20 000 ha^{-1}) compared to all other treatments which may be credited to continuous supply of nutrients in adequate proportion at specified growth stages before 135 DAP during the active growth period. Providing whole amount of RDF in active growth stage during tillering might have manifested in higher NMC which was further improved by positive interactions of N with P and K. T4 produced significantly lower NMC compared to other treatments. T2 and T3 were statistically at par with each other.Application of fertilizer in splits at and after 150 DAP in T2 and T3 did not necessarily culminate in higher NMC. Similar results were have been recorded by Madhu *et al.* (2018), Saleem *et al*. (2012), Esther (2016) and Shukla (2007a) also

The interaction between the methods of fertilizer application and number of splits was found to be non-significant in influencing the NMC.

Table 4: Effect of different methods of fertilizer application and numbers of splits of N and K on NMC and cane yield of sugarcane crop

Methods of fertilizer application	**NMC (000 ha^{-1})**		**Cane Yield (t ha^{-1})**
	September	**At Harvest**	**At Harvest**
B1- Broadcasting	93.16	88.84	85.88
B2- Band Placement	100.79	96.58	93.16
SEm±	0.77	0.68	0.69
CD (p=0.05)	**5.08**	**4.87**	**4.53**
Number of splits N and K			
T1-5 splits	102.06	95.20	94.83
T2 -6splits	98.49	93.96	90.85
T3-7splits	96.31	92.05	88.88
T4 -3splits	91.04	86.53	83.52
SEm±	0.71	0.64	0.67
CD (p=0.05)	**2.23**	**2.23**	**2.10**

Fig 3: Effect of different methods of fertilizer application and numbers of splits of N and K on numbers of millable cane of sugarcane crop

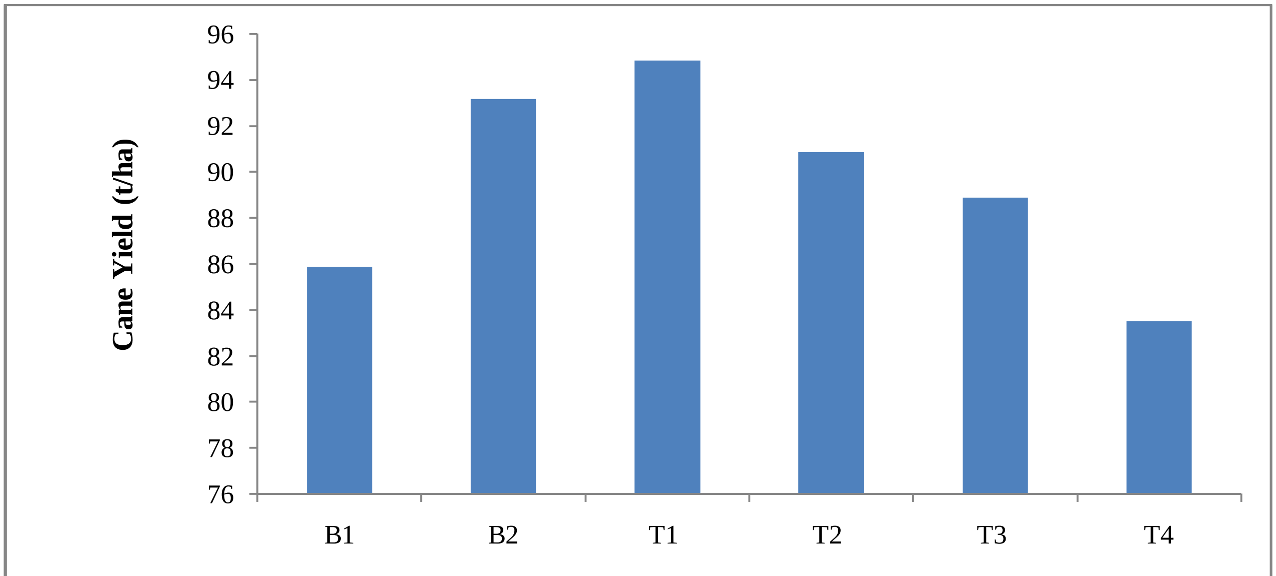


4.2.2 Cane Yield (t ha^{-1})

Cane yield is the resultant of all the yield attributes and was significantly influenced both under main and sub plot treatments. Among main plot treatments, significantly higher cane yield was registered underB2(93.16 t ha^{-1}) than B1(85.88 t ha^{-1}).might be due to uninterrupted supply of applied nutrients in the vicinity of roots which ameliorated the nutrient stress and resulted in efficient acquisition of nutrients by the sugarcane crop. Efficient translocation of nutrients to leaves after rapid absorption consecutively raised the rate of crop development by increasing NMC and ultimately cane yield. The less cane yield obtained in B2 might be associated with the wastage of applied N through ammonia volatilization and denitrification losses coupled with fixation of applied P and K rendering them less available to plant. Similar results have also been reported by Madhu *et al.* (2017a), de Castro *et al*. (2016), Chaudhari *et al.*(2010), Oliveira *et al.* (2013) and Zambrosi (2012) in their research findings.

Among the sub plot treatments, maximum cane yield (94.83 t ha^{-1}) was recorded under T1 than tall other treatments.T1 produced 4.3, 6.6, 13.5 % higher cane yield than T2, T3, and T4 respectively.Higher yield in T1 may be due to higher NMC, cane length, girth and weight (Nassar *et al*., 2005; Saleem *et al*., 2012) as a result of establishment of perfect synchrony between nutrient delivery and cop demand throughout its life cycle (Madhu *et al.*, 2017). Disbursing whole amount to fertilizer upto 120 DAP which is active growth period induced profuse tillering and its further translation into higher NMC might have leadto higher cane yield. (Madhu *et al*., 2018; Esther, 2012). Treatments T2 (90.85 t ha^{-1}) and T3 (88.88 t ha^{-1}) were statistically at par with each other while minimum cane yield was recorded with treatment T4 which might be due to early application of whole fertilizer amount which caused its non-availability in later stages due to leaching or volatilization (Saleem *et al*., 2012).Interaction between methods of fertilizer application and number of splits was found to be significant.

Fig. 4: Effect of different methods of fertilizer application and numbers of splits of N and K on cane yield of sugarcane crop



4.2.3 Cane Length

Cane length is the distance between the base of cane to the topmost matured inter-node. A small variation in individual cane length can cause a noticeable change in overall cane yield.Cane length under B2 (234.64 cm) was significantly higherthan B1(222.35 cm) which may be due to reduction of losses due to volatilization of N and fixation P respectively which in turn instigated more availability of applied N and P in the neighborhood of roots (Choudhary*et al*., 2016).

Among the sub plot treatments receiving RDF in different number of splits, treatment T1(240.90 cm) outperformed all other treatments and produced significantly taller canes compared to other treatments. The canes produced in T1 were 4.71, 6.65 and 10.93 percent lengthier than cane produced in treatments T2(230.06 cm), T3(225.86 cm) and T4(217.15 cm), respectively. T3 and T2 were statistically at par with each other. More harmonized supply of nutrients according to crop demand in T1 may have elevated the crop growth rate which further resulted in increased internode length leading to lengthier canes (Saleem *et al*., 2012). These findings have also been recorded by Esther (2016).The interaction between the methods of fertilizer application and number of splits was found to be non-significant in influencing the cane length.

4.2.4 Cane Girth

Cane girth refers to the average circumference of cane and the data pertaining to cane girth (Table 5) It is clear from data that cane girth is not significantly affected either main or sub plot treatments.maximum values of cane girth were observed in B2 and T4 in main and sub plot treatments respectively which may be due presence of applied nutrients in abundance during the cane formation leading to higher crop growth rate (Saleem *et al*., 2012) but it was not sufficient enough to significantly manipulate the values of cane girth from other treatments (Esther, 2015). Contrasting observations were registered by Choudhary *et al.* (2016).

4.2.5 Number of internodes

Inter-node refers to a portion of cane between two nodes and number of internodes directly influences cane length. Number of internodes per cane was counted at harvesting and data obtained (Table 5) revealed that it was not significantly affected by either main or sub plot treatments.Numerically higher values were recorded in B1 and T1 among main and sub plot treatments respectively.may be due to greater availability of nutrients in B1due to banding and compatibility of nutrient supply according to crop demand in T1. However, effect of treatments was not large enough to significanty increase number of internodes than other treatments.Similar findings were recorded by Esther (2016) and Legesse *et al.* (2015). Interaction between methods of fertilizer application and number of splits was non- significant.

4.2.6 Length of Inter-node

Length of inter-node refers to distance between two consecutive nodes on stem. It was recorded at harvesting and it can be inferred from the it was not significantly affected either by methods of fertilizer application or number of splits.Higher length of internodes under B2 (13.85 cm) and T1 (13.92 cm)were recorded among main and sub plot treatments. It can be attributed to higher nutrient absorption and crop growth rate due to effective nutrient management techniques resulting in elongated internodes (Saleem *et al*., 2012). However, treatments failed to exert significant affect on length of internodes with respect to other treatments. These findings are in consonance with Esther (2016) and Legesse *et al*. (2015) while conflicting observations were recorded by Choudhary *et al.* (2016). Interaction between main and sub plot treatments was non-significant.

4.2.7 Single Cane Weight

Average single cane weight was recorded at harvesting and the data obtained (Table no 5) points out thatamong main plot treatments significantly higher single cane weight was registered under B2 (1.028 kg) than tB1 (1.022 kg).According to Orgeron *et al.* (2003) and Nosheen and Ashraf (2003), cane weight is the resultant of cane length and thickness both of which experienced an improvement with greater diversion of nutrients to crop through banding in B2, consecutively resulting in higher cane weight (Choudhary *et al*., 2016)

Among the sub plot treatments, maximum single cane weight was recorded with treatment T1(1.032 kg). Treatments T2 (1.023 kg) and T3(1.025kg) were statistically at par with each other although single cane weight recorded by these two treatments was higher than T4(1.020 kg). More and continuous supply of fertilizers especially N during active and early grand growth stage in T1 might have resulted in intimate synchronization of nutrient availability and crop demand. As a consequence, photosynthetic activity may have raised leading to simultaneous accumulation of more food material (Singh *et al.,* 2000) which increased cane length and girth and ultimately cane weight.Interaction between methods of fertilizer application number of splits was found to be non significant.

Table 5: Effect of different methods of fertilizer application and numbers of splits of N and K on yield attributing characters of sugarcane crop

Method of fertilizer application	Cane Length (cm)	Cane Girth (cm)	Number of Internodes	Length of Internodes (cm)	Single Cane Weight (kg)
B1 Broadcasting	222.35	2.47	16	13.83	1.022
B2Band placement	234.64	2.54	17	13.85	1.028
SEm±	1.04	0.02	0.15	0.14	0.001
CD (p=0.05)	**6.83**	**NS**	**NS**	**NS**	**0.004**
Number of splits of N and K					
T1-5 splits	240.90	2.53	17	13.92	1.032
T2 -6 splits	230.06	2.44	16	13.81	1.023
T3 -7 splits	225.86	2.48	16	13.78	1.025
T4-3 splits	217.15	2.56	15	13.85	1.020
SEm±	2.45	0.04	0.48	0.29	0.001
CD (p=0.05)	**7.64**	**NS**	**NS**	**NS**	**0.004**

5. Conclusion:

Based on the performance of different main and sub plot treatments it can be concluded that band placement of fertilizer has a more pronounced effect on growth, yield attributes as compared to broadcasting method of fertilizer application which ultimately influence the cane yield in a positive manner. Application of fertilizer in five splits outperformed all the other sub plot treatments which emphasize that schedule of fertilizer application should be such that majority of nutrient supply falls under active growth period of the crop to establish a perfect synchrony between crop nutritional demand and supply through fertilizers. Increasing the number of splits of RDF to supply nutrients at later stages of crop growth is not helpful in improving productivity as majority of nutrient absorption occurs at active growth stage (45 DAP to 150 DAP).

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