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Effects of plant dry matter, quality parameters and economics of sugarcane as influenced by different tillage practices and fertility levels (*Saccharum officinarum* L.) under South Gujarat conditions

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Abstract
Field experiments was conducted during rabi season of 2017-2018 and 2018-2019 at College farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "Effects of tillage practices and fertility levels on growth, yield and quality of sugarcane (*Saccharum officinarum* L.) under South Gujarat conditions". Total sixteen treatment combinations consisting of four treatment of tillage practices T_1: Cultivation with cultivator, T_2: Sub soiling (45 cm depth & at 2 m distance in square) + Cultivation with cultivator, T_3: Deep ploughing (22.5) + Cultivation with cultivator T_4: Rotavator + Cultivation with cultivator and four treatment of fertilizer levels F_1: 75% RDN (187.5 N kg/ha), F_2: 100% RDN (250 N kg/ha), F_3: 125% RDN (312.5 N kg/ha), F_4: 150% RDN (375 N kg/ha) was laid out in Split Plot Design with three replications. The sugarcane cultivar used in the study was Co N 13073.

Different tillage practices significantly affected the periodical dry matter accumulation by plant. Significantly higher dry matter accumulation at 90 DAP (6.8, 6.32 and 6.55 t ha^{-1}), at 180 DAP (17.4, 16.3 and 16.9 t ha^{-1}), at 270 DAP (23.8, 22.1 and 23.0 t ha^{-1}) and at harvest (56.6, 52.7 and 54.7 t ha^{-1}) were observed in the treatment T_2 (Sub soiling 45 cm depth & at 2m distance in square + Cultivation with cultivator) during both the year as well as in pooled analysis while, at all periodical stages, dry matter accumulation at 90 DAP, 180 DAP, 270 DAP and at harvest found significantly higher under 125% RDN (F_3) which was found statistically at par with 150% RDN (F_4) during all stages in all the individual years.

All the quality parameters were not influenced significantly by the different tillage practices during both the years of study except commercial cane sugar yield which was found significantly higher under the treatment T_2 (Sub soiling 45 cm depth & at 2 m distance in square + Cultivation with cultivator) during second and in pooled results. All the quality parameters were not influenced by the different fertility levels during both the years of study except commercial cane sugar yield which was found significantly higher under the treatment 125% RDN (F3) followed by the treatment 150% RDN (F4).

Treatment T_2 (Sub soiling 45 cm depth & at 2 m distance in square + Cultivation with cultivator) registered maximum gross realization (₹ 4,87,243/ha) and net realization (₹ 3,79,832/ha) with B:C ratio of 3.54. While, the lowest gross realization (₹ 3,73,651/ha) and net realization (₹ 2,70,240/ha) with B: C ratio of 2.61 was obtained under T_1 (Cultivation with cultivator) treatment.

The highest gross realization (₹ 4,72,537/ha), net-realization (₹ 3,69,535/ha) and B:C ratio (3.52) were obtained with the treatment F_3 (125% RDN). While, the lowest gross realization (₹ 3,78,049/ha), net realization (₹ 2,70,755/ha) and B:C ratio (2.62) was obtained under the treatment F_1 (75% RDN).

Keywords: Sugarcane, tillage, fertility levels, dry matter, quality and economics

Introduction
Sugarcane (*Saccharum* hybrid complex*)* is one of the important agro industrial crops of India which play a crucial role in social and economical upliftment of rural population. India, the second largest sugarcane producing country after Brazil cultivated sugarcane on 4.4 million hectares area with production of 306 million tonnes of sugarcane and 20.2 million tonnes of sugar with an average productivity 69 t/ha during 2016-17 (Anonymous, 2018). Indian sugar industry is supporting approximately 6.0 million people through sugarcane cultivation and other related industries.

Sugarcane production coupled with improved quality traits needs sufficient amount of plant nutrients in the soil. Imbalanced and inadequate use of plant nutrients results in poor cane yield and emergence of multiple nutrient deficiencies. Nitrogen, phosphorus and potassium account for bulk of essential nutrients, which many soils are deficient and need

supplementation through organic and inorganic sources. Higher fertilizer doses proved to be superior in respect to growth and yield. Thus, to make the sugarcane cultivation more remunerative, there is need to refine NPK recommendation up to the desired level, therefore nutrient management is an important factor for increasing yields.

Apart from other cultural practices, fertilization is one essential input for seed cane production. In general, the importance of balanced fertilizer application to sugarcane has often been emphasized, since sugarcane by its nature requires nutrients such as nitrogen, phosphorous and potassium in large quantities. In general, nitrogen occupies the highest position in the nutrition of sugarcane. Nitrogen fertilization enhances the growth of sugarcane and enables the plants to take up other nutrients. Hebert (1965) asserted that increasing the level of nitrogen to the optimum requirements of seed cane plants correspondingly increases the quality of seed sett.

Among several factors, fertilizer is responsible for satisfactory vegetative growth and better production of sugarcane crop. The nutrients should be supplied according to crop needs at different physiological stages of the growth. The higher cane yield (109.4 t/ha) was recorded under the treatment 125% RDF followed by treatment 100% RDF (250-125-125 NPK kg/ha). The increased cane yield could be due to positive and significant correlation with number of millable cane per hectare, plant height, millable cane length, single cane weight and number of internodes per cane during both the years. However, higher dose of N promoting growth parameters might be due to fact that the net assimilation rate of the N fed to plants was accelerated due to increase in chlorophyll content and the absorbed N helped in the formation of food reservoir due to higher photosynthetic activity, which increases the growth character

Methodology

The field experiment was conducted on plot number D-15 and B-6 of the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during 2017-2018 and 2018-2019**.** Campus is geographically located at 20º57' N latitude and 72º54' E longitude at an altitude of 10 meters above the mean sea level. Data on soil analysis revealed that soil of experimental plot was clay in texture. The soil of the both plots (on an average of both years) was medium in available nitrogen (269.85 kg/ha), medium in available phosphorus (27.7 kg/ha) and fairly rich in available potassium (372.65 kg/ha) and slightly alkaline in reaction (8.01).

The experimental field was prepared by tractor drawn implements. The subsoiling, deep ploughing and rotavator practice was carried out in the month November-December during both the years as per treatment details. Ridges and furrows were opened at a distance of 100 cm with the help of tractor drawn ridger. Plots were laid out as per the plan given in Fig. 3: during both the years. The essential channels required to irrigate the plots were opened with the help of tractor drawn ridger.

A common dose of 125 kg P_2O_5 ha^{-1} and 125 kg K_2O ha^{-1} in the form of single super phosphate and murate of potash, respectively, were applied uniformly to all the experimental plots prior to planting and it was mixed with the soil. Whereas, nitrogen was applied in the form of urea in all treatments in four splits as 15 per cent at the time of planting, 30 per cent at 45 days after planting, 20 per cent at 90 days after planting and 35 per cent before final earthing-up *i.e.*150 days after planting fertilizer were manually applied uniformly in all the experimental unit during both the year as per the treatments.

Two eye budded setts obtained from sugarcane varieties (CoN 13073) were used @ 50,000 per hectare. Two eye budded setts were planted in furrows after treating with 0.1 per cent solution each of Emisan and Melathion for control of fungal and insect infestation. The planting was done using seed rate of 50,000 two eye bud setts *i.e.* planting 100 cm between rows. The setts were arranged in the field and covered with soil in wet planting method. Tube well having good quality water was used for irrigation. During the entire growth period 14 irrigations were given during 2017-18 and 2018-2019 with 20-22 days interval in winter and 15- 18 days interval in summer season, respectively.

Results and Discussion

Plant dry matter

Periodical total dry matter accumulation by sugarcane plant are presented in Table 11 and graphically depicted in Fig. 6.

Effect of tillage practices

Different tillage practices significantly affected the periodical dry matter accumulation by plant. Significantly higher dry matter accumulation at 90 DAP (6.8, 6.32 and 6.55 t ha^{-1}), at 180 DAP (17.4, 16.3 and 16.9 t ha^{-1}), at 270 DAP (23.8, 22.1 and 23.0 t ha^{-1}) and at harvest (56.6, 52.7 and 54.7 t ha^{-1}) were observed in the treatment T_2 (Sub soiling 45 cm depth & at 2m distance in square + Cultivation with cultivator) during both the year as well as in pooled analysis, respectively. However, it was found statistically at par with the treatment T_3 (Deep ploughing (22.5 cm) + Cultivation with cultivator) and treatment T_4 (Rotavator + Cultivation with cultivator) during second year only. Treatment T_1 (Cultivation with cultivator) recorded the lowest dry matter accumulation at 90, 180, 270 DAP and at harvest during all the individual years as well as in pooled analysis.

Effect of fertility levels

At all periodical stages, dry matter accumulation at 90 DAP, 180 DAP, 270 DAP and at harvest found significantly higher under 125% RDN (F_3) which was found statistically at par with 150% RDN (F_4) during all stages in all the individual years except at 180 DAP in second year (2018-19). The lowest dry matter accumulation was observed under the treatment of 75% RDN (F_1) at all periodical stages during both the individual year as well as in pooled analysis.

Interaction effect

The interaction between tillage practices and fertility levels with respect to periodical dry matter yield was non-significant during consecutive two years and in combined analysis.

Table 1: Periodical plant dry matter accumulation of sugarcane as influenced by different tillage practices and fertility levels

Treatments	Plant dry matter accumulation (t/ha)											
	90 DAP			180 DAP			270 DAP			At harvest		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Main factor: Tillage practices (T)												
T_1	4.9	4.88	4.90	12.7	12.6	12.7	17.2	17.1	17.2	41.0	40.6	40.8
T_2	6.8	6.32	6.56	17.4	16.3	16.9	23.8	22.1	23.0	56.6	52.7	54.7
T_3	6.0	5.99	6.01	15.6	15.5	15.5	21.1	21.0	21.0	50.2	50.0	50.1
T_4	5.7	5.88	5.79	14.7	15.2	15.0	19.9	20.6	20.3	47.4	49.0	48.2
SEm ±	0.13	0.22	0.13	0.35	0.56	0.33	0.47	1.76	0.45	1.12	1.82	1.07
CD (P=0.05)	0.47	0.76	0.40	1.21	1.95	1.02	1.63	2.65	1.38	3.89	6.30	3.30
CV%	7.97	13.1	10.8	7.97	13.1	10.8	7.97	13.1	10.8	7.97	13.1	10.8
Sub factor: Fertility levels (F)												
F_1	4.7	4.57	4.64	12.1	11.8	12.0	16.5	16.6	16.2	39.2	38.1	38.7
F_2	5.9	5.89	5.92	15.3	15.2	15.3	20.8	20.6	20.7	49.5	49.1	49.3
F_3	6.6	6.56	6.59	17.1	16.9	17.0	23.1	22.9	23.0	55.1	54.6	54.9
F_4	6.2	6.06	6.11	15.9	15.7	15.8	21.6	21.2	21.4	51.4	50.5	50.9
SEm ±	0.15	0.20	0.13	0.39	0.52	0.33	0.53	0.71	0.44	1.27	1.69	1.06
CD (P=0.05)	0.44	0.59	0.36	1.15	0.53	0.93	1.55	2.07	1.26	3.70	4.94	3.01
CV%	7.99	12.2	10.7	8.99	12.2	10.7	8.09	12.3	10.7	8.99	12.2	10.7
Interaction (T x F)												
SEm ±	0.30	0.41	0.72	0.80	1.05	0.66	1.06	1.42	0.89	2.53	3.39	2.11
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Quality studies

The data on quality in terms of brix per cent, pol (sucrose) content in juice (percentage), pol (sucrose) content in cane (percentage), purity percentage, C.C.S. percentage, commercial cane sugar (C.C.S.) yield (t/ha) and fibre percentage as influenced by the different treatments are presented under appropriate sub headings.

Effect of tillage practices

Various tillage practices treatments had no significant effect on brix percentage, pol% (sucrose) content in juice, pole% (sucrose) in cane, purity (%) of juice and commercial cane sugar (%) during both the years of experimentation and pooled study. However, treatment T_2 (Sub soiling 45 cm depth & at 2m distance in square + Cultivation with cultivator) observed numerically higher this all quality parameters respectively, and lower with T_1 (Cultivation with cultivator) during both the year of experimentation and pooled analysis, respectively.

Effect of fertility levels

Various fertility levels operations had no significant effect on brix percentage, pol% (sucrose) content in juice, pole% (sucrose) in cane, purity (%) of juice and commercial cane sugar (%) during both the years of experimentation and pooled study. However, Treatment F_3 (125% RDN) observed numerically higher this all quality parameters respectively, and lower with treatment 150% RDN (F_4) during both the year of experimentation and pooled analysis, respectively.

The fertility levels operations exerted their significant effect on commercial cane sugar during both the years of experimentation as well as in combined analysis. Treatment F_3 (125% RDN) resulted significantly higher commercial cane sugar (20.2, 16.6 and 19.4 t/ha) which was statistically at par with treatment 150% RDN (F_4) during individual years of investigation and in pooled analysis, respectively.

Interaction effect

The interaction between tillage practices and fertility levels with respect to on brix percentage, pol% (sucrose) content in juice, pole% (sucrose) in cane, purity (%) of juice, commercial cane sugar (%) and commercial cane sugar was non-significant during in combined analysis

Table 2: Effect of tillage practices and fertility levels on yield attributes and yield component of sugarcane

Treatments	Brix	Pol (%) juice	Pol (%) cane	Purity co efficient (%)	C.C.S (%)	C.C.S (t/ha)	Fiber (%)
Main: Tillage practices(T)							
T_1	18.6	17.2	14.9	85.8	14.0	14.4	12.5
T_2	20.3	19.0	16.5	95.1	15.1	20.0	13.7
T_3	19.7	18.5	16.0	92.6	14.8	18.9	13.3
T_4	19.1	18.3	15.5	91.5	14.1	15.8	12.9
SEm ±	0.54	0.51	0.41	3.67	0.43	0.77	0.34
CD (P=0.05)	NS	NS	NS	NS	NS	2.36	NS
CV%	13.6	13.8	12.7	13.8	14.5	21.8	12.7
Sub: Fertility levels (F)							
F_1	18.9	17.6	15.2	88.1	14.2	14.6	12.6
F_2	19.3	18.1	15.7	90.5	14.4	17.0	13.1
F_3	20.0	18.9	16.4	94.7	14.9	19.4	13.6
F_4	19.5	18.3	15.6	91.7	14.6	17.9	13.0
SEm ±	0.50	0.40	0.30	2.69	0.46	0.61	0.25
CD (P=0.05)	NS	NS	NS	NS	NS	1.73	NS
CV%	12.7	10.6	9.45	10.6	15.5	17.3	9.45
Interaction (T x F)							
SEm ±	1.0	0.79	0.61	5.35	1.92	1.22	0.51
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Economics

The data on the economics of sugarcane crop as influenced by tillage practices and fertility levels are furnished in Table 31. The gross as well as net realization, additional income over control and cost-benefit ratio for individual treatments were worked out on the basis of pooled cane yield, considering prevailing market prices.

Effect of tillage practices

Data revealed that the treatment T_2 (Sub soiling 45 cm depth & at 2 m distance in square + Cultivation with cultivator) registered maximum gross realization (₹ 4,87,243/ha) and net realization (₹ 3,79,832/ha) with B:C ratio of 3.54 followed by treatment T_3 (Deep ploughing (22.5) + Cultivation with

cultivator) with gross realization of ₹ 4,57,886/ha, net realization of ₹ 3,53,675/ha and B:C ratio of 3.39. While, the lowest gross realization (₹ 3,73,651/ha) and net realization (₹ 2,70,240/ha) with B:C ratio of 2.61 was obtained under the treatment T_1 (Cultivation with cultivator).

Effect of fertilizer level

The highest gross realization (₹ 4,72,537/ha), net-realization (₹3,69,535/ha) and B:C ratio (3.52) were obtained with the treatment F_3 (125% RDN) followed by treatment F_4 and F_2. While, the lowest gross realization (₹ 3,78,049/ha), net realization (₹ 2,70,755/ha) and B:C ratio (2.62) was obtained under the treatment F_1 (125% RDN).

Conclusion

From the two years of experimentation, it can be concluded that sub soiling 45 cm depth & at 2 m distance in square + cultivation with cultivator or deep ploughing (22.5 cm) + cultivation with cultivator along with 125% RDN (312.5 kg N/ha) was found beneficial for securing higher cane yield, infiltration rate and economic returns under south Gujarat condition.

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