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Research Paper

Effect of land configurations, establishment techniques and sources of nutrients on *Suru* sugarcane (*Saccharum officinarum*) under Konkan conditions of Maharashtra

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ABSTRACT

Field experiment was conducted during *suru* (*Saccharum officinarum* L.) season (January) of 2014–17 to investigate the effect of land configurations, establishment techniques and sources of nutrients on *suru* sugarcane (*Saccharum officinarum* L.) under Konkan condition, at Agronomy Farm, College of Agriculture, Dapoli, Maharashtra. Weather during both the years was favourable and suitable for cultivation of sugarcane. The experiment was laid out in strip-split plot design comprising of 36 treatment combinations replicated thrice. Horizontal strips consisted of three land configurations. The vertical strips consisted of four establishment techniques with three sources of nutrients. Horizontal strips consisted of land configurations, viz. ridges and furrow (C_1), broad bed furrow (C_2) and flat bed (C_3). Vertical strips consisted of establishment techniques, viz. Planting two bud sets in field (M_1), planting single bud settlings raised in soil + FYM in 1:1 proportion (M_2), planting single bud settlings raised in soil + cocopeat in 1:1 proportion (M_3) and planting single bud settlings raised in soil + vermicompost in 1:1 proportion (M_4) while sources of nutrients, viz. application of 100% RDF through straight fertilizers (F_1), application of 75% RDF through Modified Konkan Annapurna briquettes 2:1:1 (F_2) and application of 50% RDF through modified Konkan Annapurna briquettes 2:1:1 (F_3). From the 3 years investigation, it is concluded that for obtaining higher yield and net returns from sugarcane in lateritic soils of Konkan region, it should be grown by paired row planting on ridges and furrows with drip irrigation by using single bud settling raised in soil + FYM in 1:1 proportion and should be fertilized with recommended dose of fertilizers (250:125:125 kg NPK/ha) through straight fertilizers.

***Key words**:* Establishment techniques, Land configurations, Sources of nutrients, Suru sugarcane, Yield

Sugarcane (*Saccharum officinarum* L.) is an old energy source for human beings and more recently, a partial replacement as an alternative fuel source for fossil fuels and highly management responsive crop. It has been grown in South East Asia and western India since 327 B.C. and has been an important crop in the Indian sub-continent since then. Sugarcane is the second most important industrial crop of India with highest production of sugar after Brazil.

Determination of precise planting technique (land configuration) to improve uniformity in plant population and crop productivity in sugarcane is an important issue. Among different planting methods ridges and furrows planting method is much prevalent in Maharashtra. Flat method of sugarcane planting is easy in operation and takes less time in planting but results in lower germination (30–35%) and plant population (Singh and Brar 2015). Paired row planting method (60:120 cm spacing) gave significantly higher cane yield than conventional (75 cm row spacing) planting (Singh *et al*., 2012).

Konkan region is bestowed with assured rainfall with annual average of 3,500 mm. In spite of such huge rainfall, the region faces scarcity of water after monsoon season. Thus, efficient use of water plays an important role for agricultural production in this region. Experimentation for several seasons had led to recommend *suru* plantation of sugarcane in Konkan during December to January (Anonymous, 1981). Large scale agro based Rasvanti business is flourishing in Konkan for about 200 days in a year. In this region large number of sugarcane crushers need considerable quantity of sugarcane for extracting juice.

Sugarcane being a non-conventional crop for farmers in

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Konkan, most of them go for a popular method of planting three budded sets conventionally. The recent studies at national level have brought out the fact that the conventional method of planting three budded setts is costlier besides wastage of valuable seed material, poor germination as compared to recently evolved technique of Sustainable Sugarcane Initiative (SSI) (Kumaran and Sangeetha, 2011). Use of single bud sugarcane setts as a planting material significantly improved the germination in nursery and tillering under field conditions as compared to two budded setts (Sanap, 2014). Therefore, for avoiding wastage of seed material and to enhance germination, survival and tillering behaviour of single bud settlings should be prepared by using different germinating media.

The sugarcane is long duration and high-yielding crop, which gives response to fertilizer application. The high cost of manuring and fertilization is a basic problem in sugarcane cultivation. These difficulties need to be tackled through minimizing the present recommended dose of NPK fertilizer by increasing fertilizer use efficiency without sacrificing the cane yield. Significant improvement in all growth characters and cane yield of sugarcane were noted due to briquette form over non-briquette form. Increase in fertilizer use efficiency by using briquettes over non-briquette fertilizers for sugarcane was also noted by More *et al*. (2012).

Hence, the investigation was undertaken to optimize the fertilizer use efficiency and assess the possibility of saving of fertilizers through briquette in sugarcane under different land configurations with suitable establishment techniques.

The experiment was conducted during *suru* season (January) of 2014–15, 2015–16 and 2016–17 to investigate the effect of land configurations, establishment techniques and sources of nutrients on *suru* sugarcane under Konkan condition at Agronomy Farm, College of Agriculture, Dapoli, located at the 17° 1' North latitude and 73° 1' East longitude. It is in the tropical region having an elevation of 250 m above the mean sea level. The climate of the locality is hot and humid. The mean maximum temperatures ranged from 26.5°C to 35.5°C and mean minimum temperatures from 12.6°C to 26.3°C respectively. Weather is the most important factor affecting the performance of the crop.The average rainfall during experimental period was more (3,650 mm) and equally distributed. In short, the weather during both the years was favourable and suitable for cultivation of sugarcane. The soil analysis indicated that the experimental plot was clay loam in texture, medium in available nitrogen (310.21 and 314.46 kg/ha) and low in available phosphorus (10.18 and 10.72 kg/ha), medium in available potassium (262.81 and 268.23 kg/ha), high in organic carbon (0.96 and 0.98%) and slightly acidic in reaction (*p*H 6.01 and 6.03). From the data, it is clear that the soil of experimental plot was clay loam in texture, slightly acidic in reaction with high organic carbon content. It was medium in available nitrogen, low in available phosphorus and medium in available potassium.

The field experiment was laid out in strip-split plot design comprising of 36 treatment combinations replicated thrice. Horizontal strips consisted of three land configurations. The vertical strips consisted of four establishment techniques with three sources of nutrients. Horizontal strips consist of land configurations, viz. ridges and furrow (C_1), broad-bed furrow (C_2) and flat bed (C_3). Vertical strips consist of establishment techniques, viz. planting two bud setts in field (M_1), planting single bud settlings raised in soil + FYM in 1:1 proportion (M_2), planting single bud settlings raised in soil + cocopeat in 1:1 proportion (M_3) and planting single bud settlings raised in soil + vermicompost in 1:1 proportion (M_4) while sources of nutrients, viz. application of 100% RDF through straight fertilizers (F_1), application of 75% RDF through Modified Konkan Annapurna briquettes 2:1:1 (F_2) and application of 50% RDF through modified Konkan Annapurna briquettes 2:1:1 (F_3). The sugarcane crop is planted at 120 cm × 30 cm (Paired row planting) spacing with variety Co-92005.

Ploughing of the experimental field was done with a tractor-operated plough followed by clod crushing with tractor-operated rotavator. Then planking was done with the help of tractor to level the field and to bring it in good tilth during the years of the experimentation. Furrows were opened by tractor-operated ridger for preparing ridges and furrows. The leveling of broad bed furrows was done manually. Broad beds were prepared with the help of ridger by keeping bed bottom width 180 cm, top width 120 cm and height 15 cm with 30 cm furrow width.

Application of straight fertilizers and modified Konkan Annapurna briquettes

Fertilizer application: The crop was fertilized with 250 kg N, 125 kg P_2O_5 and 125 kg K_2O /ha in (F_1) RDF treatment. At the time of planting 10% dose of nitrogen and entire dose of P_2O_5 and K_2O were applied by placement method just before planting of sugarcane crop. Remaining N were applied in 3 split doses @ 40, 10 and 40% at an interval of six weeks from each preceding dose. Fertilizers were given in the form of straight fertilizers, i.e. urea, single super phosphate and muriate of potash respectively. *Briquette application:* In case of treatment F_2 and F_3, i.e. 75% and 50% RDF through modified Konkan Annapoorna Briquettes, briquettes were applied by deep placement method. Modified Konkan Annapurna Briquettes were applied @ 685 kg/ha in treatment F_2 and 457 kg/ha in treat-

ment F_3. Briquettes were prepared in 2:1:1 ratio (N:P:K) with help of briquette machine. 50% briquettes were applied at time of *in situ* planting and remaining 50% at 135 days after *in situ* planting with the help of crow bar at about 7 to 10 cm depth in soil. The holes were covered with soil.

Briquette preparation: The briquettes were prepared as per the ratio of fertilizers combination used with the help of 'Krantibriquetter'. Each briquette contains 3.0 g weight. The composition of modified Konkan Annapurna Briquettes in F_2 was GROMOR (complex fertilizer of 14:35:14 NPK grade) 265.5 kg + urea 327 kg + MOP 93 kg comprising 685.50 kg briquettes for one ha area. While in case of treatment F_3 composition of modified Konkan Annapurna Briquettes was GROMOR (complex fertilizer of 14:35:14 NPK grade) 177 kg + urea 218 kg + MOP 62 kg consisting of 457.00 kg briquettes for one ha area.

Preparation of seed material for planting: Seed canes of sugarcane variety Co 92005 having age of 10 months were obtained from Regional Sugarcane and Jaggery Research Station, Kolhapur for nursery preparation as well as *in situ* planting.

Preparation of single bud setts: Single bud setts were prepared with the help of "Khilare sugarcane cutter" by cutting seed canes 2.5 cm above the bud and 5–6 cm below the bud. These single bud setts were sown in plastic portrays of 56 cm × 36 cm size having 42 rectangular cups with 70 mm length, 50 mm width and 75 mm depth. Single bud settlings were raised in soil along with different media, viz. FYM, cocopeat and vermicompost as per treatments in 1:1 proportion by weight.

Transplanting of settlings: After settlings were raised as per treatments and attained an age of 45 days, settlings were transplanted under dry condition in such a way that all sett roots were placed below soil surface and the experimental plot was irrigated immediately. When experimental plot reached to field capacity condition, individual transplanted settlings were pressed at surface soil to ensure firm contact of sett roots with soil and second irrigation was given.

Irrigation: In the present investigation experimental plot was irrigated through drip irrigation at alternate day from planting up to commencement of monsoon and after withdrawal of monsoon till maturity of the crop.

During the preparation of settlings, setts are treated with 300 ml malathion and 100 g bavistin/100 litre water are soaked for 20 minutes for control of stem-borer. The control of rats in standing crop was done by baiting zinc phosphide 1:50 ratio near the live burrows. During the course of present investigation, periodical growth observations, yield contributing characters and yield were recorded to evaluate the treatment effects. The concentration of macro- nutrients (N, P and K) and its uptake by crop was studied. Economics of the treatment combinations was also worked out.

Effect of land configurations

The growth parameters, viz. millable cane height and dry matter accumulation influenced periodically by different treatments are presented in Table 1.

The data revealed that growth parameters, viz. millable cane height and dry-matter accumulation/plant of sugarcane was not significantly influenced by different land configurations at all the growth stages during the period of experimentation. Numerically more plant height and dry matter was recorded in treatment of ridges and furrows during experimentation. It might be due to ridges and furrow system has the advantage of draining excess water around the plant during rainy season. This in turn, provided adequate aeration, pore space for proper germination, seedling emergence and root growth, which ultimately increased the availability of nutrients. The results were in agreement with the results reported by Bhuller *et al*. (2002).

The yield attributing characters, viz. length of cane, girth of cane, number of internodes/cane and number of millable canes/ha influenced by different treatments are presented in Table 1. Yield attributing characters, were not significantly influenced by different land configurations at harvest during experimentation. Further, due to congenial condition in ridges and furrows it tends to be physiologically more active plants which was indicated in growth performance and its precursor was reflected in yield attributes and yield of sugarcane, therefore the sink, viz. length of cane, girth of cane, number of internodes and number of millable canes/ha. The increased photosynthetic area can assimilate more photosynthates and the ratio of source to sink was maintained in ridges and furrows during all the years. These findings are in close conformity with those of Patil *et al*. (2010).

The yield of sugarcane/ha, i.e. millable cane yield, green top yield, trash yield and total biological yield was not influenced significantly by different land configurations at harvest during the experimentation. The numerically higher values recorded under treatment (C_1) ridges and furrows might be due to proper utilization of rain-water by the crop which improved overall growth and yield attributing characters and finally the yield. The evaluation carried out indicated that due to ridges and furrow planting, germination of eye buds as well as growth was not adversely affected by heavy and continuous rain as well as stagnant water. The furrow between two ridges also act as drainage chan-

Table 1. Effect of land configurations, establishment techniques and sources of nutrients on plant height (cm), dry-matter accumulation/plant, length of cane, girth of cane, no. of internodes, no. of millable canes/ha, millable cane yield, green top yield, trash yield and biological yield of sugarcane

Treatment	Plant height (cm)			Dry matter accumulation/ plant (g)			Length of cane (cm)	Girth of cane (cm)	No. of internodes/ cane	No. of millable canes/ha (000)	Millable cane yield (t/ha)	Green top yield (t/ha)	Trash yield (t/ha)	Biological yield (t/ha)
	240 DAP	300 DAP	At harvest	240 DAP	300 DAP	At harvest								
Land configurations														
C_1	157.5	202.3	224.6	397.8	551.1	744.6	225.0	10.3	21.8	90.6	117.4	14.9	9.2	141.2
C_2	155.5	199.3	224.0	391.0	549.1	740.4	224.5	10.2	21.3	89.3	113.1	14.1	8.6	136.0
C_3	152.9	196.2	221.4	385.5	536.5	728.9	222.6	10.2	21.1	88.6	111.1	14.0	8.7	133.8
SEm±	2.1	2.4	1.5	4.2	5.2	4.3	1.3	0.1	0.5	2.4	3.1	0.4	0.2	0.2
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Establishment methods														
M_1	155.5	200.5	225.0	400.9	553.7	747.8	225.7	10.3	21.6	92.8	118.1	14.8	9.2	142.1
M_2	163.851	208.5	230.1	417.7	571.2	768.5	229.4	10.5	22.6	94.4	122.6	15.5	9.5	147.7
M_3	149.0	190.2	214.6	361.3	511.8	700.8	216.4	10.0	20.7	80.1	99.4	12.7	7.5	119.6
M_4	153.0	197.8	223.5	385.7	547.1	734.8	224.8	10.1	20.7	90.8	115.4	14.3	8.8	138.6
SEm±	3.200	3.3	2.5	9.9	8.7	11.5	2.3	0.1	0.4	2.7	4.1	0.4	0.3	0.2
CD (*P*=0.05)	NS	11.5	8.6	32.5	25.1	42.8	7.8	0.3	1.5	9.5	14.1	1.3	1.2	0.7
Sources of nutrients														
F_1	161.9	203.7	227.0	403.5	558.1	753.7	227.8	10.4	22.0	96.1	120.2	15.8	9.2	145.1
F_2	153.2	198.9	224.3	390.1	542.7	738.1	224.3	10.2	21.1	87.5	114.4	14.7	9.1	138.4
F_3	150.7	195.2	218.7	380.7	531.1	722.1	220.1	10.1	21.2	85.0	106.9	12.4	8.1	127.5
SEm±	1.4	1.6	1.2	5.9	6.2	7.8	1.2	0.1	0.3	2.5	2.1	0.3	0.2	0.2
CD (*P*=0.05)	3.9	4.4	3.4	17.8	19.0	22.9	3.4	NS	0.7	7.0	6.3	1.0	0.5	0.5
Interaction effect														
C × M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C × F	NS	7.6	5.9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M × F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C × M × F	NS	NS	NS	NS	NS	NS	NS	NS	NS	24.3	NS	NS	NS	NS

*NS, Non-significant.

nel through which excess water drains out from the field, while at the end of monsoon, these furrows support to conserve moisture. These findings are in line with the findings of Kumar *et al*. (2014) and Patil *et al*. (2010).

The data regarding available nitrogen, phosphorus and potassium (kg/ha) in soil after harvest of sugarcane as influenced by different treatments are presented in Table 2. Perusal of the data presented in Table 2 revealed that, the differences in the nitrogen, potassium and phosphorus availability in soil after harvest of crop did not reach to the level of significance due to different land configurations during all the years of experimentation. Numerically higher nitrogen, phosphorus and potassium were available in the soil under flatbed configuration during all the years.

Effect of different land configurations on total cost, gross return, net returns and B:C ratio was found to be non-significant. However higher total cost, gross return, net returns and B:C ratio was observed in treatment (C_1) ridges and furrows.

Effect of establishment techniques

Plant height and dry-matter accumulation were significantly influenced due to different establishment techniques (Table 1). Planting of single bud settlings raised in soil+ FYM in 1:1 proportion (M_2) recorded significantly higher plant height as well as dry-matter accumulation as compared to planting of single bud settlings raised in soil + cocopeat in 1:1 proportion (M_3) and remained at par with *in situ* planting of two bud setts (M_1) and planting of single bud settlings raised in soil + vermicompost in 1:1 proportion (M_4) during the experimentation. Further, due to higher growth in treatment planting of single bud settlings raised in soil + FYM in 1:1 proportion tends to physiologically more active plants which was indicated in growth performance and its precursor was reflected in yield attributes and yield of sugarcane, therefore the sink, viz. length of cane, girth of cane, number of internodes and number of millable canes/ha. However planting single bud settlings raised in soil+ FYM in 1:1 proportion was followed by planting of two-bud setts in field and planting of single bud settlings raised in soil + vermicompost in 1:1 proportion during the study. These increased photosynthetic area which can assimilate more photosynthates during the experimentation period. This might be due to supply of ample amount of sunlight for producing higher chlorophyll content which enables the crops photosynthetically more active and therefore, higher dry-matter accumulation which was reflected in recording of superior values of growth parameters. Also as compared to *in situ* planting, the higher plant height, and dry-matter were observed in case of different rooting media under study. This was mainly because of the fact that soil alone had the highest bulk density, particle density and least per cent pore space, which caused late germination resulting in poor root growth, lower leaf number/plant and dwarf settlings. Moreover, the improved plant height and dry-matter production in case of rest of the rooting media could be due to favourable conditions of rooting media, viz. increased per cent pore space, improved aeration and thus enhanced microbial activities needed for mineralization of nutrients to available form besides increased availability of plant growth promoting hormones.

During study the yield attributing characters, viz. length of cane, girth of cane, number of internodes/cane and number of millable canes/ha were significantly influenced due to different establishment techniques. Planting of single bud settlings raised in soil+ FYM in equal proportion (M_2) recorded significantly the higher yield attributing characters as compared to planting of single bud settlings raised in soil + cocopeat in 1:1 proportion (M_3) and remained at par with rest of all establishment techniques in respect of all the yield attributing characters except number of internodes/cane which were significantly superior over (M_3) planting of single bud settlings raised in soil + cocopeat in 1:1 proportion and planting single bud settlings raised in soil + vermicompost (M_4). These findings are in close conformity with those of Silverio (1977) and Shinde (1984).

Data in respect of yield of sugarcane in Table 1 indicates that the planting of single bud settling raised in soil + FYM in 1:1 proportion recorded significantly the higher yield of sugarcane, i.e. millable cane yield, green top yield, trash yield and biological yield (t/ha) as compared to treatment M_3 (Planting of settling raised in soil + cocopeat in 1:1 proportion) and remained at par with rest of the treatments except in respect of biological yield, the treatment M_2 remained significantly superior over rest of the all treatments. Yield is a function of growth and yield attributes. High production of total dry matter was first prerequisite for high yield. The data pertaining to yield viz. millable cane yield, green top yield, trash yield and biological yield of sugarcane at harvest exhibit significant effect. This could be due to the fact that rooted settlings with rooting media were transferred to the field due to which related micro-organisms might have worked for favourable effects on crop by their activities in rhizosphere as plant growth promoting rhizomicrobes, which besides fixation of nutrients like N, mineralize native soil nutrients to available form and resist bacterial and fungal pathogens in respect of their pathogenic activities to the crop.The increased yield attributes might be due to increased growth and development parameters which ultimately resulted in increased yield. These results corroborated the findings of Shukla and Lal (2003).

Scrutiny of the data presented in Table 2 indicates that, different establishment techniques did not influence significantly the availability of nitrogen, phosphorus and potas-

sium in the soil after harvest of sugarcane during all the years of observations. Numerically higher nitrogen, phosphorus and potassium were available in the soil by planting of single bud settlings raised in soil + cocopeat during all the years of study.

In case of economics treatment, *in situ* planting of two bud setts (M_1) recorded significantly the higher total cost as compared to rest of the treatments. In respect of gross returns, net returns and B:C ratio, significantly the higher gross returns, net returns and B:C ratio were recorded in treatment of planting of single bud settlings raised in soil + FYM in equal proportion (M_2) and was at par with all other treatments except the planting of single bud settlings raised in soil + cocopeat in 1:1 proportion (M_3) which was significantly lower than rest of the treatments. The present results are in consonance with those of Bhullar *et al*. (2002).

Effect of sources of nutrients

Data presented in Table 1 implies that significantly higher plant height as well as dry matter accumulation were recorded by treatment F_1, i.e. application of 100 % RDF through straight fertilizers as compared to treatment F_3, i.e. application of 50% RDF through modified Konkan Annapurna briquettes and which was remained at par with treatment F_2, i.e. application of 75% RDF through modified Konkan Annapurna briquettes during the study. Nutrients play very vital role in physiology of crop and are essential for the transformation of carbohydrates and regulate consumption of sugars and play important role in enzyme activation. Therefore, it may be emphasized that application of macronutrients in 100% recommended dose of application rates, significantly improved overall growth of the crop in terms of dry matter production/plant by virtue of its impact on morphological and photosynthetic components along with accumulation of nutrients. This suggests the greater availability of nutrients and metabolites for growth and development of reproductive structure, which ultimately led to realization of the higher productivity of individual plants. These results are in agreement with those of Shukla (2007).

Among the different sources of nutrients, application of 100% RDF through straight fertilizers recorded significantly the higher values of all yield attributing characters of sugarcane as compared to application of 50% RDF through modified Konkan Annapurna Briquettes and remained at same bar with application of 75% R.D.F. through modified Konkan Annapurna briquettes. This increased photosynthetic area which assimilated more photosynthates during the study. This might be due to the supply of nutrients which might have increased the protoplasmic constituent and accelerated the process of cell division and elongation. These findings are in close conformity with those of Kumar *et al*. (2006).

During the study, yield of sugarcane, i.e. millable cane yield, green top yield, trash yield and biological yield were

Table 2. Effect of land configurations, establishment techniques and sources of nutrients on available nitrogen, phosphorous and potassium (kg/ha) in soil

Treatment	Available N (kg/ha)			Available P (kg/ha)			Available K (kg/ha)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Land configurations									
C_1, R and F	301.2	296.7	299.0	9.4	9.4	9.5	251.8	248.1	252.9
C_2, BBF	305.8	298.8	307.3	9.5	9.4	9.5	254.7	249.3	258.1
C_3, Flat bed	309.5	301.9	309.4	9.5	9.4	9.5	257.8	255.0	260.1
SEm±	1.1	1.1	1.1	0.004	0.005	0.006	1.05	0.6	1.2
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Establishment techniques									
M_1, *In situ*	305.9	297.8	301.9	9.4	9.4	9.4	252.7	248.5	250.6
M_2, Soil + FYM.	305.7	299.7	302.7	9.4	9.3	9.3	241.1	238.0	239.6
M_3, Soil + Coco.	306.2	300.3	303.3	9.5	9.5	9.5	263.8	258.8	261.3
M_4, Soil + Vermi.	304.3	298.7	301.5	9.5	9.5	9.5	261.4	257.9	259.6
SEm±	1.6	2.3	1.9	0.02	0.02	0.02	1.9	2.0	1.9
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sources of nutrient									
F_1, 100% RDF	312.8	306.2	309.5	9.5	9.4	9.5	259.0	254.5	256.7
F_2, 75% KAB	304.7	297.2	301.0	9.5	9.4	9.5	254.8	250.9	252.9
F_3, 50% KAB	299.0	293.9	296.5	9.4	9.4	9.4	250.5	247.0	248.8
SEm±	0.6	1.7	1.1	0.01	0.01	0.01	0.4	0.5	0.5
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Initial nutrient status	310.2	314.5	312.9	10.2	10.7	10.4	262.8	268.2	264.7

significantly influenced by different sources of nutrients. The application of 100% RDF through straight fertilizers recorded significantly the higher sugarcane yield as compared to application of 50% RDF through modified Konkan Annapurna briquettes and it was remained at par with application of 75% RDF through modified Konkan Annapurna briquettes during the experimentation except in respect of biological yield, the treatment F_1 was significantly superior over all the sources of nutrients. The increase in cane yield of sugarcane may be accounted for significant improvement in yield attributes which finally converted into yield. Similar results were reported by More *et al*. (2012) and Kumar *et al*. (2013).

The data presented in Table 2 insinuates that, availability of nitrogen, phosphorus and potassium was not significantly influenced due to sources of nutrients. Application of 100% RDF through straight fertilizers recorded higher availability of nitrogen, phosphorus and potassium during the years of study.

The data presented in Table 3 revealed that source of nutrient 100% RDF recorded significantly higher total cost, gross returns, net returns and B:C ratio over the rest of the nutrient sources. The present results are corroborated by those of Keshavaiah *et al.* (2012).

Table 3. Economics of treatments affected by different land configurations, establishment techniques and sources of nutrients in sugarcane.

Treatment	Total cost (× 10^3 ₹/ha)	Gross returns (× 10^3 ₹/ha)	Net returns (× 10^3 ₹/ha)	Benefit cost ratio
Land configurations				
C1	277.3	306.9	29.5	1.10
C2	273.8	294.7	20.9	1.07
C3	272.1	290.5	18.4	1.06
SEm±	1.6	8.7	7.4	0.03
CD (*P*=0.05%)	NS	NS	NS	NS
Establishment methods				
M1	282.9	307.2	24.3	1.08
M2	270.2	320.1	49.9	1.18
M3	270.9	260.6	-10.3	0.96
M4	273.8	301.5	27.7	1.10
SEm±	1.6	9.3	7.8	0.03
CD (*P*=0.05)	5.5	32.0	26.9	0.10
Sources of nutrients				
F1	280.9	316.1	35.1	1.12
F2	275.2	298.6	23.5	1.07
F3	267.2	277.4	10.1	1.04
SEm±	0.9	4.8	3.9	0.01
CD (*P*=0.05)	2.7	13.5	11.3	0.04
Interaction effect				
C × M	NS	NS	NS	NS
C × F	NS	NS	NS	NS
M × F	NS	NS	NS	NS
C × M × F	NS	NS	NS	NS

Interaction effects

The interaction effects between land configurations, establishment techniques and sources of nutrients failed to exhibit any significant effect on mean plant height and dry-matter accumulation at all the growth stages of crop, yield contributing characters, yield and economics of sugarcane during the experimentation.

From the investigation, it is concluded that for obtaining higher yield and net returns from sugarcane in lateritic soils of Konkan region, it should be grown by paired row planting on ridges and furrows with drip irrigation by using single bud settling raised in soil + FYM in 1:1 proportion and should be fertilized with recommended dose of fertilizers (250 : 125 : 125 kg NPK/ha) through straight fertilizers.

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