INTERNATIONAL JOURNAL OF FORESTRY AND CROP IMPROVEMENT (June, 2011); 2 (1) : 25-29

RESEARCH ARTICLE

Received : Jan., 2011; Accepted : March, 2011

Influence of bio-fertilizer strains on sugarcane (*Saccharum* spp. hybrid complex) production

H.M. VIRDIA

ABSTRACT

A field experiment was conducted on heavy black soil at Regional Sugarcane Research Station, Navsari Agricultural University, Navsari (Gujarat) during 2003-04 to 2006-07 to evaluate the effect of various strains of *Acetobactor diazotrophicus* and other bio-fertilizers along with 75% of recommended N through fertilizer and the control on the productivity of sugarcane (*Saccharum officinarum* L.). Application of 100 % N of RFD induced the higher growth and yield attributes and yield of sugarcane over no N and 25% lower dose of N. The no nitrogen application treatments recorded lower growth and yield attributes and yield of sugarcane. All bio-fertilizer treatments along with 75% N of RFD remained equally effective. However, *Azotobactor* soil inoculation was more effective than *Acetobactor* strains under study.

KEY WORDS : *Acetobacter,* Bio-fertilizer*,* *Azotobacter,* Sugarcane

Virdia, H.M. (2011). Influence of bio-fertilizer strains on sugarcane (*Saccharum* spp. hybrid complex) production, *Internat. J. Forestry & Crop Improv.,* **2** (1) : 25-29.

INTRODUCTION

Sugarcane is the important source of sugar industries and it cultivated on large area in many countries. In India, sugarcane is grown through out the country except Jammu & Kashmir and Himachal Pradesh. In Gujarat sugarcane cultivation covers more than 2.00 lakh ha. Among this intensively it is grown under South Gujarat where large number of co-operative sugar factories are working and have canal irrigation.

Improved sugarcane yield can be attributed to high yielding varieties, use of synthetic fertilizers and better irrigation facilities. However, in recent years there is a growing concern world wide on issues such as reduction in cane production, excess use of irrigation water, excessive use of agrochemicals and how that affects soil fertility, quality of produce and the environment. Wide spread problems such as deterioration of soil fertility have caused concern all over. The idea of organic farming and sustainable agriculture is becoming popular. Biological agents will play an important role in the new environmentally safe strategies.

Sugarcane growers used high amount of fertilizers to their field even though the productivity has declined due to mismanagement of fertilizer application and poor soil health. There is a need to focus attention on the biological approaches for keeping control over the fast deteriorating situation. This approach includes use of organics and bio-fertilizers to supply plant nutrients to the plants. Bio-fertilizers are best described as micro organisms which add, conserve various nutrients and make available to plant for management of land resources. Bacterial species *viz., Rhizobium, Azotobactor, Acetobactor, Azosprillum, Phosphobacterium* etc. is used as bio-fertilizer in various crops. Application of bio fertilizers reducing cost of cultivation, maintaining soil fertility and preserve soil nutrients.

Acetobacter diazotrophicus has been reported effective association for bacterial nitrogen fixation in sugarcane (Solayappan, 1995). This bacterium seems to be best adapted in the sugarcane environment and more efficient than the other existing nitrogen fixers in sugarcane fields. This has high nitrogen fixing efficiency in sugar rich atmosphere and can fix atmospheric nitrogen up to 30% sugar. Various species of these bacterium are available, locally isolated strains require testing for its effectiveness in the sugarcane growing region. Therefore, an experiment was designed to compare locally isolated *Acetobactor diazotrophicus* strains on growth and yield of sugarcane variety CoN-91132 under South Gujarat condition.

Correspondence to:
H.M. VIRDIA, Regional Sugarcane Research Station, Navsari Agricultural University, NAVSARI (GUJARAT) INDIA

MATERIALS AND METHODS

The field experiment was conducted during 2003-04 to 2006-07 at Regional Sugarcane Research Station, Navsari Agricultural University, Navsari (Gujarat). The soil was deep black clayey with normal pH and EC and low to medium in available P_2O_5 and K_2O. The experiment was laid out in different field during the first three year as plant crop and on 4[th] year ratoon crop was taken. The initial soil status was as per Table 1.

Table 1 : initial soil status

Characteristics	2003-04	2004-05	2005-06
pH (1:2:5)	7.86	7.36	7.58
EC (1:2:5)	0.25	0.16	0.19
Available N (kg/ha)	306	188	210
Available P_2O_5 (kg/ha)	121	62	30
Available K_2O (kg/ha)	583	407	488

The experimental design was Randomized block design with 14 treatments and 3 replications. The treatments includes various strains of *Aceptobactor* with 75% recommended dose of N (250 kg N/ha), RDF (250:125:125 kg NPK ha) and absolute control (No N-Application – No bio-fertilizer). P and K was applied as per recommendation in all the treatments as basal and N fertilizer was applied in 4 splits as 15% basal, 30% at 1½ month after planting, 20% at 3 month after planting and 35% at final earthing up (5-6 month after planting). Bio-fertilizer treatment were applied as fresh culture obtained from bio-fertilizer unit AAU, Anand (*Acetobactor* strain A1 to A8) and remaining from market were mix with soil at the rate of 2 kg/ha and make slurry by adding water such that each sets completely covered with culture slurry. These treated sets were immediately planted in respective plots. At the time of final earthing up same culture was applied after mixing with soil and keeping two days in shade and directly applied in the root zone before earthing up. *Azotobactor* culture was applied as soil application at the time of planting as well as at final earthing up @ 2 kg/ha each time. Sugarcane variety CoN-91132 was planted at the row spacing of 90 cm with seed rate of 1,00,000 eye buds/ha (50,000 two eye budded sets/ha) in the December every year. The treatment details are as below:

Treatment details:

T_1, Sets treatment with A1 *Acetobactor* strain; T_2, Sets treatment with A_2 *Acetobactor* strain; T_3, Sets treatment with A_3 *Acetobactor* strain; T_4, Sets treatment with A4 *Acetobactor* strain; T_5, Sets treatment with A_5 *Acetobactor* strain; T_6, Sets treatment with A_6 *Acetobactor* strain; T_7, Sets treatment with A7 *Acetobactor* strain; T_8, Sets treatment with A8 *Acetobactor* strain; T_9, Sets treatment with super culture (G.S.F.C.) *Acetobactor* strain; T_{10}, Sets treatment with Kribhco *Acetobactor* strain; T_{11}, Soil application of *Azotobactor;* T_{12}, Soil application *Azotobactor* + PSB+ sets treatment with *Acetobactor* strain; T_{13}, Recommended dose of fertilizer [*i.e.* 250-125-125 kg NPK/ha]; T_{14}, Control [*i.e.* No N + Recommended dose of P&K]; [Note : 75% RD of N was applied to Treatment T_1 to T_{12}]

RESULTS AND DISCUSSION

The results obtained from the present study have been discussed in detail under following heads :

Number of millable cane:

The number of millable canes increased with increase in nitrogen level. Significantly highest number of millable canes was recorded with the treatment T_{13} (*i.e.* application of RDF) and lower number was with no N application treatment (T_{14}). However, during the 1[st] and 3[rd] year of study statistically all the treatments remained similar (Table 3). Treatment with no N fertilizer reported lower number of millable canes during all the years as well as in pooled results. All bio-fertilizer treated treatments have almost similar number of millable cane (Table 3). This might be due to immediate and initially sufficient nitrogen available with 100% recommended fertilizer treatment (T_{13}). Shukla (2007) also reported that nitrogen fertilization increased tillering and growth in sugarcane. Optimum nutrient management for sugarcane plant crop plays key role, as it establishes vigorous stubble, resulted in more tillers which reflected in more number of millable cane development, while bio-fertilizer supply atmospheric nitrogen as per environmental conditions, if environment is unfavorable to bio-organisms it not perform well resulted in poor population of microbes in soil which unable to supply required quantity of nutrients to growing sugarcane plants, this may affect on tillering and subsequently to cane development. Tillering period in sugarcane is the most important growth phase which governs the cane yield in subtropical India (Shukla,2007)

Cane yield:

Significantly higher cane yield in all the years in plant as well as in ratoon crops and in pooled analysis were recorded with application of 100% N of RDF. It was statistically superior to no N(T_{14}) and N fertilizer applications @ 75% of RDF along with bio-fertilizer

Table 2 : Effect of bio-fertilizer and chemical fertilizer on growth parameter (Pooled)

Treatments	Germination (%) at 45 DAP	Tillering % at 90 DAP	Total plant height (cm) at harvest	Millable plant height (cm) at harvest	Number of internodes / cane at harvest	Cane girth (cm) at harvest	Cane diameter (cm) at harvest
T_1	52.36	163.52	286.56	249.67	25.50	7.02	2.24
T_2	51.25	162.10	288.44	249.56	25.37	7.01	2.23
T_3	49.22	167.67	285.11	251.33	25.71	7.07	2.25
T_4	56.14	164.36	285.11	247.56	25.53	7.08	2.25
T_5	49.14	165.66	297.00	249.78	25.59	7.06	2.25
T_6	54.38	177.21	283.78	248.56	25.24	6.19	2.20
T_7	53.09	170.39	294.44	245.44	24.90	6.89	2.19
T_8	51.44	163.84	287.44	251.11	24.97	6.93	2.21
T_9	55.40	164.33	291.33	257.33	25.57	7.23	2.30
T_{10}	48.94	179.13	288.11	251.44	25.43	6.99	2.23
T_{11}	52.10	155.68	285.00	249.11	25.18	7.02	2.24
T_{12}	56.52	162.29	289.33	253.00	25.49	7.22	2.30
T_{13}	52.63	172.79	297.67	260.89	25.34	7.13	2.27
T_{14}	49.40	142.08	265.33	237.67	24.62	6.78	2.16
C.D. (P=0.05)	NS	NS	13.34	9.79	NS	NS	NS

NS=Non-significant

treatments (T_1 to T_{12}). While lowest yield was with the treatment in which fertilizer N was not applied (Table 4). There is no second opinion that chemical fertilizers contribute a major share for enhancing the productivity of cane. The steady supply of plant nutrients in adequate quantities during growing and developmental stages of sugarcane increased the availability of plant nutrients in the soil and mediates favorable environment for the absorption of nutrients. This again exerts positive effects on growth and development of cane and may be due to more and immediate availability of nutrients especially in recommended dose of fertilizer resulted in more number of tillers and vegetative growth (Table 2) which reflected in the cane yield. Role of nitrogen in increasing tillering and growth is well recognized (Shukla, 2007). Nitrogen is known to increase vegetative growth and sugarcane is harvested for their vegetative mass, so more N application resulted in more vegetative growth which reflected in cane yield. The result is in conformity with the findings of Bangar *et al.* (2000) and Singh *et al.* (2004). Among the various bio-fertilizer treatments soil application of *Azotobacter* culture(T_{12}) gave higher yield but it failed to produce significant difference from other bio-fertilizers treatments. Bio-fertilizers are capable of synthesizing growth hormones and growth regulators in addition to the fixation of N. The phytohormones and other growth regulators liberated in the treatment under *Azotobacter* (T_{11}) might have produced favourable effects in the soil for cane growth and nutrient uptake. This might have contributed for improving the cane yield with *Azosprillum* soil inoculation as compared to *Acetobacter* sets treatment (Nagaraju *et al.*, 2000).

Table 3 : Effect of bio-fertilizer and chemical fertilizer on Number of millable cane at harvest

Treatments	2003-04	2004-05	2005-06	Pooled
T_1	1,35,833	1,29,722	1,00,278	1,21,944
T_2	1,32,450	1,25,833	1,00,556	1,19,630
T_3	1,44,722	1,25,556	96,111	1,22,130
T_4	1,41,944	1,27,778	1,07,500	1,25,740
T_5	1,35,278	1,25,000	1,01,389	1,20,556
T_6	1,51,944	1,21,945	1,05,000	1,26,296
T_7	1,32,500	1,19,167	1,06,667	1,19,444
T_8	1,41,945	1,24,167	1,10,833	1,25,648
T_9	1,40,000	1,19,444	1,10,278	1,23,241
T_{10}	1,41,389	1,28,055	97,778	1,22,407
T_{11}	1,40,556	1,30,556	1,00,556	1,23,889
T_{12}	1,31,667	1,17,500	1,05,833	1,18,333
T_{13}	1,56,667	1,36,667	1,15,000	1,36,111
T_{14}	1,26,111	95,278	93,333	1,04,907
C.D. (P=0.05)	NS	16277	NS	9814

NS=Non-significant

Growth parameters:

Various growth parameters *viz.*, germination(%), tillering (%), number of internodes, cane girth and cane diameter were not affected due to various treatments under study (Table 2). However, plant height was higher with full dose of N fertilizer through inorganic fertilizer (T_{13}), while lower plant height was reported with no N application treatments (T_{14}). It may be due to initial sufficient N availability from fertilizer, which encourages

Table 4 : Effect of bio-fertilizer and chemical fertilizer on cane yield (t/ha)

Treatments	2003-04	2004-05	2005-06	2006-07	Pooled
T_1	112.315	118.241	83.333	85.555	99.861
T_2	110.463	115.463	81.296	83.704	97.732
T_3	110.463	119.630	70.648	88.611	97.338
T_4	114.167	118.056	72.407	87.407	98.009
T_5	110.278	112.778	70.000	86.389	94.861
T_6	110.000	112.222	73.241	84.630	95.023
T_7	113.611	114.630	75.833	87.593	97.917
T_8	117.685	117.222	70.370	85.833	97.778
T_9	111.667	113.241	77.037	94.815	99.190
T_{10}	115.648	113.796	75.926	87.963	98.333
T_{11}	118.704	113.241	80.926	93.889	101.689
T_{12}	117.222	114.815	68.611	86.018	96.67
T_{13}	122.778	131.482	96.389	96.667	111.829
T_{14}	92.222	86.574	60.000	64.260	75.764
C.D.(P=0.05)	13.9	11.3	15.8	10.9	6.1

Table 5 : Effect of bio-fertilizer and chemical fertilizer on C.C.S. (t/ha)

Treatments	2003-04	2004-05	2005-06	Pooled
T_1	13.41	13.81	9.81	12.31
T_2	13.94	13.96	9.91	2.604
T_3	13.51	14.53	8.40	12.15
T_4	13.94	14.35	8.98	12.42
T_5	13.81	13.87	8.24	11.97
T_6	13.34	14.01	8.92	12.09
T_7	14.01	14.41	9.06	12.09
T_8	14.54	14.52	8.53	12.50
T_9	13.85	14.10	9.32	12.53
T_{10}	14.48	14.11	9.02	12.54
T_{11}	14.56	13.99	9.93	12.82
T_{12}	14.43	14.65	8.07	12.38
T_{13}	15.36	16.40	11.86	14.54
T_{14}	11.35	10.89	7.13	9.79
C.D. (P=0.05)	1.66	1.38	1.89	0.91

better primary growth, nitrogen is considered to be the most limiting factor for realizing higher yield. Nitrogen is the most deficient element in soil and plants like sugarcane require more nitrogenous fertilizers for their vegetative growth and crop production. An adequate supply of nitrogen is associated with efficient source to sink relationship leading to higher productivity. Thus, application of 100% N of RDF resulted in higher value of growth parameters. The results are in confirming with the findings of Bangar *et al.* (2000) and Thomas and Kuruvillla(2005).

Commercial cane sugar(C.C.S.) production:

The higher C.C.S. production was reported with treatment T_{13} (Full dose of fertilizer) and lower with treatment T_{14} (no N application). All other treatments remained similar for C.C.S. production. The higher yield of C.C.S. may be due to higher yield of cane in the respected treatments (Table 5) as well as better juice quality with more nutrient availability. The results are in agreement with the findings of Sharma *et al.*(1999) and Thomas and Kuruvillla (2005).

Economics:

The highest gross and net income was reported with treatment T_{13} (Full dose of fertilizer) and lower return with treatment T_{14} in which no N was applied. This was reflected in the BCR ratio (Table 6). More net return and CBP value with higher N level also reported by Singh *et al.* (2007)

The study indicated that the yield of sugarcane

Table 6 : Economics

Treatments	Yield (t/ha)	Additional yield over control t/ha	Additional income	Additional cost over control	Additional cost Benefit ratio
T_1	99.861	24.097	33736	1989	15.96
T_2	97.732	21.968	30755	1989	14.47
T_3	97.338	21.574	30204	1989	14.18
T_4	98.009	22.245	31143	1989	14.66
T_5	94.861	19.097	26736	1989	12.44
T_6	95.023	19.259	26963	1989	12.56
T_7	97.917	22.153	31014	1989	14.59
T_8	97.778	22.014	30820	1989	14.50
T_9	99.190	23.426	32796	1989	15.49
T_{10}	98.333	22.569	31597	1989	14.89
T_{11}	101.689	25.925	36295	1989	17.25
T_{12}	96.667	20.903	29264	2188	12.37
T_{13}	111.829	36.065	50491	3695	12.67
T_{14}	75.764	-	-	-	-

Price : N = 10.90 /kg Sugarcane seeds Rs. 1600/t

improved by the nitrogen application and bio-fertilizer partly fulfill N requirement of the crop but it may not reach the level up to full dose of N application. Bio fertilizer with 25% less chemical fertilizer may reduce chemical load on soil and there by it may increase the microbial activity in soil which improve soil health.

REFERENCES

Banger,K.S., Parmar,B.B. and Maini, Asok (2000). Extent of association of nitrogen and pressmud cake on growth, yield, nutrient uptake and quality parameters of sugarcane. *Crop Res.* (Hisar) **19**(2):255-259.

Nagaraju,M.S., Shankariah, C. and Ravindra, U. (2000). Effect of integrated use of fertilizers with sulphitation pressmud and *Azotobacter* on growth and yield. *Co-operative Sugar,* **3**(5): 391-95

Sharma,B.L., Prasad,K., Singh, P.K., Sharma, S. and Singh, S.B. (1999). Sulphitation pressmud cake in sugarcane.(In) Integrated approach with inorganic nitrogen. *Indian J. Agric. Chem.,* **32** (1,2) : 1-5.

Shukla,S.K. (2007). Growth yield and quality of high sugarcane (*Saccharum officinarum*) genotypes as influenced due to planting seasons and fertility levels. *Indian J. Agric. Sci.,* **77**(9):569-573.

Singh, A.K., Lah, Menhi, Prasad, S.R. and Srivastava, T.K. (2007). Productivity and profitability of winter-initiated sugarcane (*Saccharum* spp. hybrid complex) ratoon through intercropping of forage legumes and nitrogen nutrition. *Indian J. Agron.,* **52**(3):208-211.

Singh, D., Yadav, R.L., Singh, J.P. and Pande, R. (2004). Growth and yield of sugarcane as influenced by nitrogen levels and green manuring. *Indian J. Plant Physiol.,* **9**(3): 269-274.

Solayppan (1995). *Sugarcane bio-technology*. pp. 84-91.

Thomus, Methew and Kuruvillla, Varughese (2005). Integrated nutrient management for sustainable cane production. *Indian J. Agron.,* **50**(3):231-235.

****