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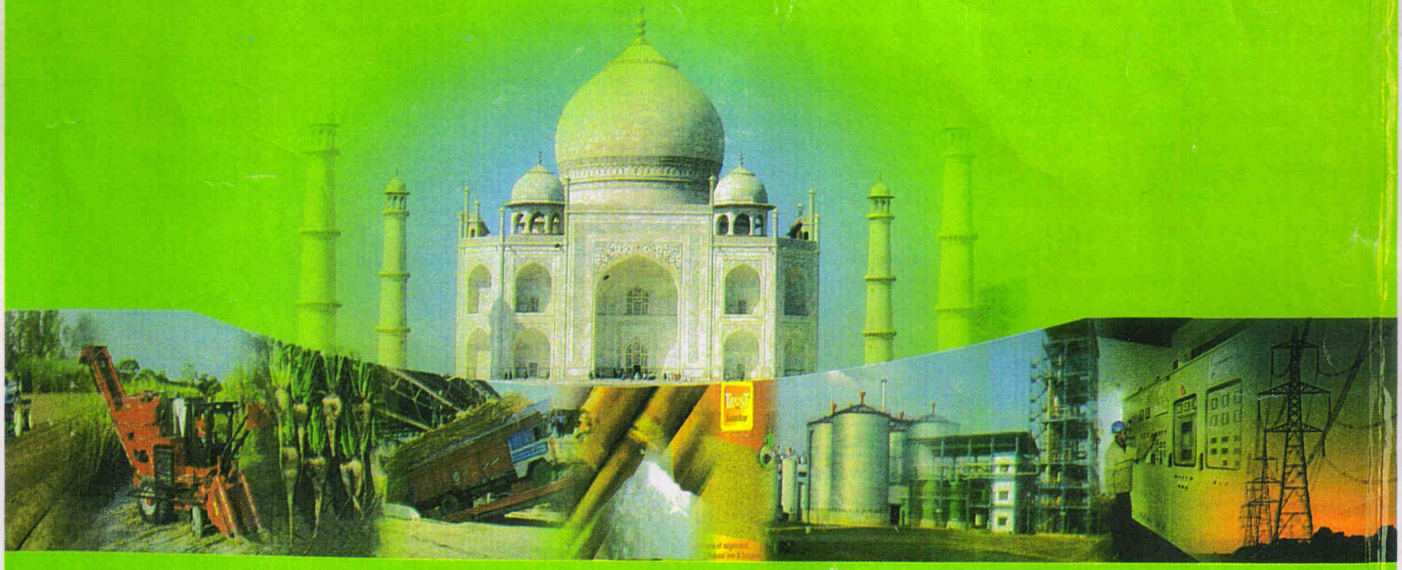

Editors

Yang-Rui Li
M.K. Srivastava, G.P. Rao, Priyanka Singh
S. Solomon

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BIO INOCULANTS – A STEP FORWARD IN SUGAR PRODUCTIVITY AND SUSTAINABILITY

M. RAVI PRATAP[1], M ARUN KUMAR[1] AND G.P. RAO[2]

1 Biocontrol Lab (P) Ltd, Plot No. 58, H.No. 2-28-206, 1st Floor, AP Text Book Colony, Karkhana, Secunderabad 500 009, India

2 Society for Sugar Research & Promotion, A-155, Weavers' Colony, Ashok Vihar ,Phase-IV, New Delhi 110052,India

Abstract

The experiment was conducted with a bio-inoculant Hi-Brix (comprising various bio-inoculants+1.2 kg of potash) mixed with 10 kgs of FYM per acre on five leading varieties (CoS 95422, CoSe 01235, UP 97, CoS 99269, CS 98231) in eastern Pradesh at Gorakhpur during the year 2009-2010. The growth parameters yield and quality data showed that the soil application of Hi-Brix at the time of plating increased the crop vigour, yield and sucrose per cent as compared to control both in plant canes and ratoon crops, respectively. The incidence of natural pests (borers) and leaf spots (caused by fungal species) is also recorded minimum in treated plots as compared to control plots. In Plant crops, the yield was increased up to 4 to 7 per cent in all the test varieties over untreated. However, the sucrose per cent in juice was enhanced from approximately from 3 to 7 per cent in November and 3 to 8 per cent in March, respectively. In ratoons, the increase in cane yield of 3-5 per cent was recorded. However, the sucrose per cent in juice was enhanced from 2.8- 5.03 per cent in November and from 4.69 to 6.73 per cent in March, respectively over untreated plots. In view of the above, our results clearly indicated that the HiBrix bioinoculant was found very promising in increasing the sugarcane crop vigour, yield and sucrose per cent in juice in commercial cultivars of sugarcane in Eastern Uttar Pradesh. Lliquid formulations with high count of bacteria (< 10^9) when used in a combination of nitrogen fixing bacteria, phosphorus solubilizing bacteria and potash mobilizing bacteria to sugarcane crop as fertilizer, it produced beneficial results both to the cultivator and the mill apart from enhancing the soil health.

Key words: *Azospirullum, Azotobacter, potash mobilizing bacteria, phosphorus solubilizing bacteria, energy savings, yield, quality, soil health*

INTRODUCTION

Sugarcane is an important industrial crop of India with an approx. 4.2 million hectare area. The extensive cereal based cropping and lack of legumes led the soil poor in organic carbon content. Sugarcane is a very demanding crop, as for a cane yield of 100 t/ha, it needs about 205 kg N, 55 kg P_2O_5, 275 kg K_2O and a large amount of micronutrients from soil (Yaduvanshi and Yadav 1990). Since its fertilizer consumption is higher than that of other crops it has negative effect on soil health in the long term.

Farmers are looking for various means to lower the input costs and at same time for the improvement of the output. The sugar mills are making untiring efforts to improve sugar recovery.The growing demand for organic sugar is an emerging opportunity.Usage of bio fertilizers and bioinoculants are the very viable options. However, no significant benefits were perceived by the farmers who have used powder grade bio fertilizers because the powder forms suffer from the disadvantages of very short shelf life and high contamination levels.

In order to sustain productivity, major nutrients are provided each year at the recommended application rates of 150 kg/ha of N and 60 kg each of P_2O_5 and K_2O for sugarcane. The efficiency of sugarcane to utilize N range between 16 and 45% as large quantities of applied N leach down through soil layer due to irrigation (Yadav and Prasad 1992). Deterioration in the physico-chemical and biological properties of soil is considered to be the prime reason for declining sugarcane yield and productivity. Howver,the bio-inoculant and bio-fertilizer application increases crop growth through combination of BNF, growth promoting / hormonal substances, increased availability of soil nutrients and disease/pest resistance. The importance of bio-fertilizer lies in the ability to supplement/ mobilize soil nutrients with minimal use of non renewable resources (Bhatttacharyya and Kumar 2000; Raghu and Macrae 2000).

Concerning the above problems the current study was focused on the use of a new bioinoculant formulation to enhance the sugarcane growth and also to assess the functional potentialities in relation to plant growth promoting activities with the objectives to study the effect of microbial inoculants on growth and nutrient uptake in sugarcane, standardizing the efficient combination of bioinoculants for maximizing sugarcane productivity and to explore the possibility of reduction in inorganic fertilizer input through bioinoculant application.

Corresponding author: arun@ipmbio.com

Table 1 : Effects of Hi-brix on Sugarcane varieties (Plant Crop) 2009-10

S.No	Varieties	Tillers (/ha)		NMC(/ha)		Cane Yield(t/ha)		Sucrose			
		T	C	T	C	T	C	November		March	
								T	C	T	C
1	CoS 95422	232000	213083	147688	135022	72.34	68.89	15.14(+3.2%)	14.65	19.56(+7.87%)	18.02
2	CoSe 01235	190324	184382	126770	122405	70.13	66.54	16.34(+6.60%)	15.26	19.53(+7.06%)	18.15
3	UP97	222116	198703	132325	130234	81.04	75.24	14.17(+4.58%)	13.52	18.34(+2.83%)	17.82
4	CoS 99269	214694	205407	125467	121055	70.68	67.76	14.55(+5.01%)	13.82	18.65(+6.64%)	17.41
5	CoSe 98231	204522	198822	138765	131043	83.46	80.12	18.45(+7.21%)	17.75	20.33(+7.27%)	18.85

NMC - Number of Millable Canes

Table 2 : Effects of Hi-brix on Sugarcane varieties (Ratoon Crop) 2009-10

S.No.	Varieties	Shoots(/ha)		NMC(/ha)		Cane Yield (t/ha)		Sucrose			
		T	C	T	C	T	C	Nov		March	
								T	C	T	C
1	CoS 95422	198200	184563	129568	126672	79.16 (+3.03%)	76.76	16.62 (+2.28%)	16.24	20.22 (+4.69%)	19.27
2	CoSe 01235	172564	166254	124201	116878	71.22 (+4.83%)	67.78	17.42 (+3.55%)	16.80	19.53 (+6.6%)	18.24
3	UP 97	191452	186538	125453	122005	76.66 (+314%)	74.25	15.34 (+3.19%)	14.85	18.12 (+6.73%)	16.90
4	CoS 99269	190236	181224	125432	117657	63.52 (+5.08%)	60.29	16.50 (+4.96%)	15.68	18.85 (+5.58%)	17.74
5	CoSe 98231	180002	176894	128657	123556	73.66 (4.49%)	70.35	16.68 (+5.03%)	15.84	20.63 (+6.47%)	19.30

NMC - Number of Millable Canes

MATERIALS AND METHODS

The experiment was conducted in the year 2009-10 at Research farm of SSRP at Gorkahpur with three replications in a Randomized Block Design. Five sugarcane varieties (CoS 95422, CoSe 01235, UP 97, CoS 99269, CS 98231) were taken for the study. The soil of the experimental field was sandy clay loam. A kit of bioinoculants formulations (HiBrix) were formulated consisting of *Azospirulum, phosphorus solubilizing microorganism and potash mobilizing bacteria.* The experiment was conducted with 4 litres of Hi-brix, comprising of various bio-inoculants and 1.2 kg of powder potash mixed with 10 kg of FYM per acre on 5 leading varieties in eastern Uttar Pradesh at Gorakhpur during the year 2009-10. The data on tillers, NMC. Cane yield and sucrose per cent in juice in the month of November and March were recorded.For the ratoon crop the soil application of HiBrix was repeated as plant crop.

RESULTS AND DISCUSSION

Soil application with bioinoculant (HiBrix) was done as per the treatment schedule. The inorganic fertilizers were also applied as per schedule. The growth parameters, yield and quality data showed that the use of Hi-brix in general increased the crop vigor, yield and sucrose per cent in juice in all the five tested varieties as compared to control. The incidence of natural pests (borers and leaf spots caused by fungal species) is also recorded minimum in treated plots as compared to control plots. An increase in sugarcane yield up to 3-6 MTs per acre was recorded compared with control plots. The sucrose per cent was found increased from 3.2% to 7.21% in the month of November over control. However, in March, the sucrose percent was found increased from 2.83% to 7.87% (Table 1 and 2). In view of the above observations, Hi-brix was found very effective in increasing the crop vigor, yield and sucrose percent.The data on this bioinoculants is also found promising in the states of Andhra Pradesh ,Maharashtra and other parts of Uttar Pradesh during last two years in both plant and ratoon crops of sugarcane (data not shown).

It can be inferred from the report that there was an improvement in the cane yield and also in the sucrose content. Studies done elsewhere on the utility of bioinoculants in liquid grades in sugarcane crop and other crops are already available (Sheraz et al., 2010; Wani and Lee 1995).

In intensive cultivation practices the population of nutrient fixing microbes is on a constant decrease in soils due to various factors. On application of these bioinoculants, it is reported that there is an increase in bacterial population in the soil even after harvest of the crop.This increase in nutrient fixing microbes may be working in synergy to increase the uptake of non-available nutrients in soil. It is also observed that the

HiBrix treated soil has become loose and has gained water retention capacity.

Research data published by NCOF shows that there could be progressive reduction in usage of chemical fertilizers in agricultural plots. This could reduce the input cost. More importantly, there is marked reduction in the pest and disease incidence as reported in the present study. This will further result in savings in pesticides costs, application costs and losses due to pests and diseases. This needs further investigation on the using bioinoculants for developing induced resistance for pest and diseases in host plant.

In an another study done to observe the improve in uptake of nutrients by the plants, on application of the liquid grade bio inoculants ,it was observed that, the uptake of P was found to increase from 0.35 mg/plant to 1.27 mg/plant in case of Lateritic soils. The same trend was noticed in K uptake also. In Calcareous soil the uptake of P was 1.25 mg/plant and it was increased up to 6.84 mg/plant in T4. The increase of uptake of P was to the tune of 447 per cent over control. Same trend of increase was also noticed in K uptake also. In sodic soils also the uptake of P and K increased significantly as compared with other treatments (Anonymous,2005, 2008).

It can be concluded from these studies that the use of phosphorous solubilizing bio-inoculants and potash solubilizing bio-inoculants are useful in increasing the availability of P and K from the soil and also resulted in increase of the uptake of P and K by the plants.

The application of HiBrix was also attempted by sugar factories in India with result of increasing yield to an extent of 4 to 6 MT per acre. This way application of HiBrix encourage farmers to use the kits for better recoveries. A mill with crushing volumes of four hundred thousand tons of cane would get an additional income of Rs. 46 million if an increase in CCS of 5% is achieved(1US $= INR 45.00).

Ideal usage of fertilizers of N: P: K is 4: 2: 1.Due to policies of Govt. which are implemented from time to time and due the subsidies offered to the farm sector and other global circumstances which are listed well in the report www.ies.lbl.gov/ies and www.emt_india.net/ inocetsfertilizer, the NPK ratio of usage has changed to 8.5 : 2.5 : 1.Excessive nitrogen fertilizer application can also lead to pest problems by increasing the birthrate, longevity and overall fitness of certain agricultural pests.The HiBrix may be a replacement for urea and ammonium nitrate. One liter of nitrogen fixing agent can replace 100 kg of urea i.e.46 kg of chemical nitrogen(source: RCOF). However, one liter of the bioinoculant may replaces 100 kg Di ammonium Phosphate chemical fertilizer.

As Indian soils are rich in potash , by using the bio fertilizers the potash that is already available in excess in the soil can be actively used. The use of bioinoculant also helps in gthe establishment of the existing microbial niche in soil. The population thrives well and gets established in the soil. Unlike any other chemical input, it will not get exhausted nor taken away with harvest from the field. Repeated applications are required only to keep up the consistent population. Also repeated application further improves aeration and soil health. Since the HiBrix is water based , hence it is eco friendly. The technology involves only multiplication of the microbes in a sterile environment.The product also promotes aeration of the soil. In turn it promotes water holding capacity of the soil. Water losses by way of runoff and evaporation are minimized in such soils. Hence water and power are saved. In the cases of prolonged drought periods, crop loss would be minimized.As the chemical usage is reduced, the health of the soil improves. This is due to gradual leaching of the residual salts in the soil.

The increase in yield and enhanced quality parameters in the present study may be combined effect of the bioinoculants along with the inorganic fertilizers. The biofertilizers application enhanced the yield and quality parameters and also essential to maintain soil microflora population and protect soil fertility from deterioration. Significant changes in various plant growth parameters have been shown by the inoculation of various nitrogen fixing and plant growth promoting bacteria (Nayak et al. 1986; Murty and Ladh 1988; Gunarto et al. 1999). In addition to nitrogen fixation the beneficial effects has been attributed to the production of plant growth hormones (Sevilla et al. 2000).

Application of phosphorous from different sources from inorganic and as bioinoculants (AM fungi and phosphobacteria) was found to be effective in sugarcane. Continuous availability of the valuable nutrients and their persistence and colonization in soil makes the soil more fertile and healthy. The mobilization of P from soil to the plants is mediated by hairy root systems of the mycorrhizal fungi through plant roots. It commonly infected plant roots, including those of sugarcane forming beneficial symbiotic relationships (Kelly *et al.*, 1997).

The usage of these bioinoculants inturn reduces the inorganic fertilizer input and thereby reduces the cost of cultivation. With this references these bioinoculants may be recommended for their use in nutrient management and enhanced sugarcane productivity in India.

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