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Influence of Zinc Solubilising Consortiums on Yield Parameters of Suru Sugarcane

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Abstract **– A field experiment was conducted at Post Graduate Institute Farm Plant Pathology and Agril. Microbiology, MPKV, Rahuri during the year 2016-2017 (Suru plantation) to study the effect of consortium with graded levels of zinc fertilizer on sugarcane cv. CoM-0265. The bio formulations were examined under field conditions with 13 treatments including zinc solubilising bacteria and zinc solubilising fungi consortiums. The application of graded levels of $ZnSO_4$ (50%, 75% and 100% recommended dose) in combination with bacterial consortium, fungal consortium, combination of both and the commercial formulation was carried out as per the treatments. In the present study, the fungal consortium + 75 % $ZnSO_4$ treatment showed higher potential among the other treatments followed by bacterial consortium + 75% $ZnSO_4$ treatment showed highest yield. Thus, it can be informed that, the highest solubilising potential of zinc solubilising fungi consortium could be used as carrier based bio-formulation and zinc solubilising bacteria consortium as liquid bio-formulation. These findings clearly indicated that 25% savings of the Zinc fertilizers to sugarcane crop could be achieved.**

Keywords **– Zinc Solubilising Bacteria, Zinc Solubilising Fungi, Sugarcane and Yield.**

I. Introduction

Sugarcane is one of the most important cash crop influencing the economy of the country. The area under Sugarcane during 2017-2018 in India was 5.00 lakh hectare with total production of 3400 lakh metric tonn and average productivity 68 t ha^{-1}. Whereas the corresponding figure of Maharashtra state was 0.92 m ha with average production of 103.10 t ha^{-1} (Anonymous, 2018). However, productivity in Maharashtra is continuously decreasing. The major factor responsible for the decline of productivity is soil variation with deficient in micronutrients. Use of major nutrients and micronutrients are essential to increase productivity. Soil health relies balance of macronutrients and micronutrients, as well as microbial health. The increased use of nitrogen, phosphorous and potassium fertilizers devoid of micronutrients has no doubt increased the food production but it brought a host of problems related to micronutrient deficiencies, of which zinc deficiency is the most predominant. Zn plays a predominant role in the solubilization, transport and deposition of metals and minerals in the environment. Thus microorganisms play a major role in the transformation of the unavailable form of metal to available form depending upon the reactions involved and the products formed (Lovely, 1991). The secretion of organic acids appears to be the functional metal resistance mechanism that chelates the metal ions extracellularly (Li *et al.*, 2007). The submerged soils are well recognized for the lack of Zn availability to the plants; particularly due to the reaction of Zn with free sulphide (Mikkelsen and Shiou, 1977). External addition of soluble Zn to alleviate deficiency results in the transformation of about 96-99 per cent to various fractions of unavailable forms and about 1-49 per cent is left as an available fraction in the soil. This requires a system that releases the required quantity of Zn that are converted to unavailable state and retained in the soil to available form. Numerous microorganisms, especially those associated with roots have the ability to increase crop growth and productivity. This effect has been due to the involvement of these organisms in the solubilization of unavailable mineral nutrients (Cunningham and Kuiack, 1992). Zinc solubilizing potential of few micribial genera such as *Bacillus sp*, *Pseudomonas sp* and *Aspergillus sp* were explored by esearchist recently (Saravanan *et al.,* 2003). Thus microbial inoculants will be an alternative approach to overcome constraints due to synthetic fertilizer, and to revive soil's fertility resulting in the intensive farming.

The rhizospheric microorganisms play a pivotal role in the enhancement of crop production by the solubilisation of unavailable form of metal into available form. A number of organic acids such as acetic, citric, lactic, propionic, glycolic, oxalic, gluconic acid etc have been considered due to its effect in pH lowering by microorganisms (Cunnigham and Kuiack, 1992). Organic acid secreted by micro-flora increase soil Zn availability in two ways, they are probably exuded both with protons and as counter ions and consequently, reduce rhizospheric pH. Currently, very little information is available on zinc solubilisation by bacteria, their mechanisms of solubilisation and their effect on growth, Zn uptake and yield of several crops. Therefore, the present investigation was undertaken to study the effect of zinc solubalizing bacteria on yield of sugarcane.

II. Materials and Methods

A total 191 rhizosphere soil samples upto 10-20 cm depth from sugarcane field and sugarcane setts from same were collected from selected 10 district places of Western Maharashtra so as to isolate the beneficial zinc solubilizing microorganisms (ZSM). The soil samples and sugarcane setts collected from various districts of Western Maharashtra is presented are Table 1.

Table 1. Rhizosphere soil samples collected for isolation of zinc solubilizing microorganisms.

Sr. No.	Districts	Number of soil samples and setts
1	Ahmednagar	29
2	Nasik	15
3	Pune	27
4	Satara	19
5	Sangli	21
6	Solapur	24
7	Kolhapur	24
8	Nandurbar	10
9	Dhule	06
10	Jalgaon	16
	Total samples	**191**

Serial dilutions were made from 10^{-1} to 10^{-5}. After solidification, the plates were kept at 28+2ºC in BOD incubator for 4-5 days. All the isolates were inoculated on to the modified Pikovskaya's medium (Glucose,10 g; $Ca_3(PO_4)_2$, 5.0 g; $(NH_4)_2SO_4$, 0.5 g; NaCl, 0.2 g; $MgSO_4.7H_2O$, 0.1 g; KCl, 0.2 g; Yeast extract, 0.5 g; $MnSO_4$, Trace; $FeSO_4.7H_2O$, Trace; Agar, 15 g; Water, 1000 ml; pH, 7.0 ± 0.2) containing 0.1% insoluble zinc source ($ZnCO_3$). All the plates were incubated for 48 hrs at 28°C. The halo zone around the colony was measured and considered as zinc solubilizing bacteria (*Bacillus sp. and Pseudomonas sp.*) and fungi (Ghevariya and Desai, 2014).

The medium used in the study was LGI with 0.132 g^{-1} of ammonium sulphate as N source for acetobacter. The medium was prepared by incorporating insoluble zinc sources *viz*., zinc carbonate at 0.1 per cent with the carbon source sucrose at 10 per cent. The pH was adjusted to 6.0 after sterilization, with sterilized 1N NaOH or 1N HCL and the medium was added to pertriplates (Pazhaniraja and Prabudasa, 2014). The bio-formulations in liquid forms of zinc solubilising bacteria (ZSB) and powder forms of zinc solubilising fungi (ZSF) isolates were used separately.

The two eye bud setts of sugarcane Cv. CoM o265 were planted in the furrow of 100 cm row spacing and 10 cm apart by pressing them 5 cm deep in the soil. The plots of five rows with 6m length were marked and the recommended dose of 250: 115: 115 as N: P: K kg ha^{-1} were applied through straight fertilizers like Urea, single super phosphate (SSP) and muriate of potash (MOP). Four split doses of N *viz.,* 10 per cent at planting, 40 per cent at 6-8 weeks after planting, 10 per cent at 12-16 weeks after planting and 40 per cent at earthingup stage were applied. Zinc in the form of Zinc sulphate @ 20 kg/ha was applied into three levels viz*.,* 50, 75 and 100 per cent per hectare as per treatments.

The experiment was designed in randomized block statistical design having 13 treatments and three replications as given below.

T_1: Recommended dose of fertilizer (RDF), T_2: ZSB consortium + 50 % $ZnSO_4$,

T_3: ZSB consortium + 75 % $ZnSO_4$, T_4: ZSB consortium + 100 % $ZnSO_4$

T_5 : ZSF consortium + 50 % $ZnSO_4$, T_6 : ZSF consortium + 75 % $ZnSO_4$.

T_7 : ZSF consortium + 100 % $ZnSO_4$, T_8: ZSB + ZSF consortium + 50 % $ZnSO_4$

T_9 : ZSB+ ZSF consortium + 75% $ZnSO_4$, T_{10} : ZSB+ ZSF consortium + 100% $ZnSO_4$, T_{11}:Commercial formulation + 50 % $ZnSO_4$ T_{12} : Commercial formulation+75% $ZnSO_4$,

T_{13} :Commercial formulation +100% $ZnSO_4$.

Five plants randomly selected from each plot were used for field observations. The crop was harvested at an appropriate maturity stage. The plant growth observations *viz.,* millable cane height, number of internodes, cane girth, number of millable canes and yield were recorded at harvest of the crop.

III. Results and Discussion

Yield Attributes:

There was a significant difference due to the application of consortium with graded levels of $ZnSO_4$ on a number of internodes per cane presented in Table 2. The application of treatment T_6 recorded the highest number of internodes (30.67), girth (15.33 cm) and length (16.40 cm). However the treatment T_3 was at par to a number of millable cane internode and girth. The same trend was observed in number of clumps (6.33), the height of millable cane (359.90 cm) and weight of clumps (13.80 kg/clumps).

Table 2. Cane yield and yield contributing parameters of sugarcane at harvest as influenced by various treatment.

Treatments	Yield (t/ha)	Millable Cane			Internodes		
		Number/ Clump	Height (cm)	Weight (kg/clump)	Number	Girth (cm)	Length (cm)
T_1	122.19	3.67	279.30	7.95	27.33	13.47	13.63

Treatments	Yield (t/ha)	Millable Cane			Internodes		
		Number/ Clump	Height (cm)	Weight (kg/clump)	Number	Girth (cm)	Length (cm)
T_2	131.14	4.67	307.80	9.02	28.00	13.73	14.00
T_3	160.86	6.00	356.97	12.35	30.33	14.90	16.10
T_4	152.41	5.33	353.60	11.03	29.00	14.80	15.50
T_5	144.79	5.00	319.03	9.43	28.00	13.67	14.07
T_6	171.29	6.33	359.90	13.80	30.67	15.33	16.40
T_7	153.92	6.00	355.03	11.16	29.67	14.87	15.93
T_8	89.59	3.00	246.90	7.03	23.67	11.23	13.23
T_9	98.15	3.33	254.77	7.60	26.00	12.87	13.23
T_{10}	124.99	4.33	300.90	8.21	27.67	13.60	13.93
T_{11}	119.99	3.33	272.93	7.79	27.00	13.20	13.57
T_{12}	124.33	3.67	277.77	8.09	27.67	13.50	13.67
T_{13}	149.33	5.33	345.33	10.50	28.33	14.27	14.37
S.Em. $\pm$	6.83	0.66	4.20	0.94	0.80	0.56	0.65
CD at 5 %	19.95	1.94	12.25	2.75	2.33	1.63	1.90
General mean	134.08	4.62	310.02	9.54	27.95	13.82	14.43

Yield :

The application of ZSF with 75 % $ZnSO_4$ recorded the highest yield (171.29 t/ha) which was at par by the treatment of zinc solubilising bacteria with 75 % $ZnSO_4$ (160.86 t/ha). There was only 0.93 per cent difference in yield between the treatment T_6 and T_3. The highest yield contributing parameters and yield were observed in treatment T_6 and T_3 due to superior plant growth and photosynthetic activities and significantly highest uptake by plant (Amalraj *et al.,* 2012, Dahaji *et al.,* 2012 and Ghaffar *et al.,* 2011).

IV. Conclusion

From this study, the highest yield was observed in the fungal consortium + 75 % $ZnSO_4$ (T_6) *i.e.,* 171.29 t/ha followed by bacterial consortium + 75 % $ZnSO_4$ (T_3) *i.e.* 160.83 t/ha. It is concluded that, the consortium of the efficient strain of Zinc solubilizers promote the yield contributing parameter and yield which could reduce Zinc sulphate application by 25 % without any significant reduction of yield.

References

[1] Amalraj, D.L.E., Maiyappan, S. and Peter, J.A. 2012. In vivo and in vitro studies of Bacillus megaterium var. Phosphaticum on nutrient mobilization, antagonism and plant growth promoting traits. J. Ecobiotechnol., 4(1) : 35-42.
[2] Anonymous, 2018. Vasant Dada Sugar Institute, Pune. Annual Report 2018. VSI Bulletins 18(1) : 15-18.
[3] Cunningham, J.E. and Kuiack, C. 1992. Production of citric and oxalic acid and solubilization of calcium phosphate by Penicillium billai. Appl. Environ. Microbiol., 58 : 1451-1458.
[4] Dahaji, A.P., Savaghebi, R.G., Rahmani, A.H., Rejali, F., Farahbakhsh, M., Zadeh, M.B., Omidvari, M. and Lindstr, T. 2012. Symbiotic effectiveness and plant growth promoting traits in some Rhizobium strains isolated from Phaseolus vulgaris L. Plant Growth Regul. 68 : 361–370.
[5] Ghaffar, A., Ehsanullah, Akbar, N. and Khan, S.H. 2011. Influence of zinc and iron on yield and quality of sugarcane planted under various trench spacing's, Pak. J. Agri. Sci., 48(1) : 25-33.

[6] Ghevariya, K.K. and Desai, P.B. 2014. Rhizobacteria of sugarcane : In vitro screening for their plant growth promoting potentials. Res. J. Recent. Sci., 3 : 52-58.
[7] Li, T.G., Bai, R.B., Liu, J.X. and Wong, F.S. 2007. Distribution and Composition of Extracellular Polymeric Substances in Membrane - Aerated Biofilm. Journal of Biotechnology, in revised form.
[8] Lovely, D.R. 1991. Dissimilatory Fe (III) and Mn (IV) reduction. Microbial. Rev., 55 : 259-287.
[9] Mikkelsen, D.S. and Shiou, K. 1977. Zinc fertilization and behavior in flooded soils. Spec. Publ. No. 5 Comm. Agric. Bur., Farnham Royal. p. 59. Mineral Stresses. In A.R. Yeo and T. J. Flowers(ed). Approaches to Crop Improvement. pp. 175-200.
[10] Pazhaniraja, P. and Prabudoss, V. 2014. Zinc solubilizing nature of Gluconacetobacter diazotrophicus. Indian Streams Res. J., 4(5) : 120-122.
[11] Saravanan, V.S., Subramoniam, S.R. and Anthony Raj, S. 2003. Assessing in vitro solubilisation potential of different zinc solubilizing bacterial (ZSB) isolates. Brazilian Journal Microbiology. 34 : 121-125.

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