

Effect of sugar mill effluent on changes of growth and amino acid and protein contents of maize (*Zea mays* L.) plants

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Abstract

The effect of sugar mill effluent on plant growth and biochemical constituents of Maize (*Zea mays* L.) was studied in a pot culture experiment. The experiment was conducted at Botanical Garden, Department of Botany, Annamalai University, Tamil Nadu. In the pot culture experiment, maize plants were grown up to 30th days, in the soil irrigated with different concentrations of sugar mill effluent (viz, 0, 20%, 40%, 60%, 80% and 100% v/v). The inner surfaces of pots were lined with a polythene sheet. Each pot containing 3kg of air dried soil. Six seeds were sown in each pot. All pots were irrigated (500 ml) with respective concentration of test solutions daily. Plants were thinned to a maximum of three per pots, after a week of germination. The higher sugar mill effluent concentrations (above 40%) were found to affect plant growth and decreased amino acids and protein contents, but diluted effluent (up to 40%) favoured the plant growth and biochemical contents.

Keywords: Sugar mill effluents, maize, growth, and biochemical contents

INTRODUCTION

Among the various kinds of pollution, the problem of water pollution has a serious one in India, due to rapid economic and industrial developments. Polluted water is one of the biggest carriers of certain microorganisms, which cause various diseases including cholera, typhoid, dysentery and diarrhoea. The sugar industry is playing an important role in the economic development of the Indian sub continent, but the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystems. Sugar factory effluent, when discharged into the environment, poses a serious health hazard to the rural and semi-urban populations that uses stream and river water for agriculture and domestic purposes, with reports of fish mortality and damage to the paddy crops in these areas due to wastewaters entering agricultural land (Baruah et al. 1993). Sugar factory effluent has an obnoxious odour and unpleasant colour when released into the environment without proper treatment. Farmers have been using these effluents for irrigation, and found that the growth, yield and soil health were reduced. Contaminants, such as chloride, sulphate, phosphate, magnesium and nitrate, are discharged with the effluent of various industries, which create a nuisance due to physical appearance, odour and taste. Such harmful water is injurious to plants, animals and human beings.

In the present investigation, an attempt has been made to study the effects of sugar factory effluent on the growth, amino acids and protein content of maize.

MATERIALS AND METHODS

Seed materials

The certified seeds of Maize (*Zea mays* L.) were purchased from Tamil Nadu Agricultural University, Agricultural Research Station, Paramakudi, Ramanathapuram district. Seeds with uniform size, colour and weight were chosen for the experimental purpose.

Experimental soil

The soil used in the experiment was sandy loam in nature and the pH of the soil was 7.2. It contains 126 kg available N, 76 kg available P and 98 kg available K/ha, and micro nutrients of 18.32mg available Cu, 190.28mg Fe, 172mg Mn and 20.44mg Zn/kg, in this experimental soil.

Collection of sugar mill effluents

The effluent samples were collected in plastic container from the point of disposal from a sugar factory located in Thiruvannamalai District, Tamil Nadu, India, and stored in cold room until used physico-chemical parameters, such as temperature, colour, pH, biological oxygen demand (BOD), total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), chloride, alkalinity, total hardness, calcium, magnesium, sulphate, phosphate and total iron, were measured using standard methods (APHA, 1998). The different concentrations of the effluent (20%, 40%, 60%, 80% and 100%) were prepared and used for the pot culture experiment.

Pot culture experiment

The experiment was conducted at Botanical Garden, Department of Botany, Annamalai University, Tamil Nadu. The impact of sugar factory effluent on the growth and biochemical characteristics of the maize was first investigated using soil pots (15 cm height 15 cm width). About 3kg of air dried soil taken into separate pots. Five different concentrations (viz., (20%, 40%, 60%, 80% and 100%) of sugar mill effluent were prepared and poured into each pot. The control was also maintained and irrigated with tap water. The inner surfaces of pots were lined with a polythene sheet.

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Ten seeds pre-sterilized with 0.1% mercuric chloride, were sown in each pot. All pots were irrigated with 500ml of respective concentration of test solutions daily. Plants were thinned to a maximum of three per pots, after a week of germination. Each treatment including the control was replicated five times.

Growth analysis

The plant samples were collected on 30th days after sowing. Three plants from each replicates of pot was analysed for the various growth parameters such as length of root and shoot.

Biochemical estimations

Leaves of treated and control plants were used for the estimation of amino acids as per Moore and Stein (1948) and protein contents as per Lowry et al. (1951) methods.

RESULTS AND DISCUSSION

The physico-chemical parameters of the effluent were found to be above those permissible by the Indian Standards (Table-1). The analysis of sugar mill effluent showed that it is acidic in nature with brown in colour. It contained high amounts of suspended and dissolved solids. It showed a high value of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The presence of considerable amounts of calcium, magnesium, chloride, sulphate, fluoride, nitrate and silica, were also noticed in the effluent. This is in conformity with the earlier findings of Chandrasekar et al. (1998), Rathore et al. (2000) and Borole and Patil (2004).

Root and shoot growth

Root and shoot length of maize plants differed with different concentrations of sugar mill effluents in the soil (Fig-1). For lower concentrations of irrigated effluent (20% and 40%), the root and shoot length of maize plants were higher than that of control plants, which may be taken as an indication of beneficial range, while for higher concentrations of effluents (60%,80% and 100%) a decreasing trend was observed, which confirms the toxic effect of this effluents to maize plants. The above results were in agreement with the findings of Kaushik et al. (2004) who reported a clear toxicity of sugar factory effluent on the growth, photosynthetic pigments and nutrient uptake in wheat seedlings in aqueous versus soil medium. The presence of calcium and magnesium cause higher osmotic pressure, resulting in the wilting of seedlings (Gomathi and Oblisami 1992). In our study, the plant growth was highly affected due to the excess amount of chloride, alkalinity, hardness, calcium, magnesium, sulphate and phosphate in the sugar factory effluent. The root length was severely affected by the higher effluent

concentrations (100%) for Maize (*Zea mays L.*) (19.3cm) compared to the control.

Biochemical estimations

Amino acid and protein content of maize (*Zea mays L.*) were higher at low (20% and 40%) concentration of sugar mill effluent in the soil than in the control plants. Further, the values decreased with a gradual increase in effluent (60%, 80% and 100%) concentration. (Fig-2). Several authors contributed various reasons for the reduced amounts of amino acid and protein contents due to sugar mill effluent. Plants treated with higher effluent concentrations (above 40%) showed lower amounts of amino acid and protein contents due to the presence of higher magnesium concentrations and the acidic pH of the effluent. Calcium and magnesium (20 mg/L) influence plant growth, biomass partitioning and fruit yield, and create symptoms of leaf chlorosis after 8 weeks in green house tomato (Hao and Athanasios, 2004). Lasa et al. (2000) also reported that four different concentrations (0.1, 0.8, 5 and 10 mM) of magnesium affected the growth of sunflower plants grown with ammonium and nitrate and they also proved that the magnesium- fed plants had lower free amino acids and soluble protein contents in their leaves. Decrease in free amino acids at high salinity concentrations can be attributed to the inhibitory effect of the effluent on protease activity (Pulver and Ries, 1973 and Joshi and Tandom, 2003). The significant increase in the protein content of plant might be due to the potassium and nitrate in their optimum quantity present in the lower concentration of the effluent as reported by (Kadioglu and Algur, 1990) in pea plants.

CONCLUSION

This study concluded that the physico-chemical parameters, such as BOD, chloride, alkalinity, hardness, calcium, magnesium, sulphate and phosphate were relatively higher in the sugar factory effluent and severely affected the plant growth. There was a gradual decrease in the root and shoot length, amino acid and protein contents in maize (*Zea mays L.*) plants, when irrigated with various effluent concentrations (except 20% and 40%) compared to the control. Effluent at 20% and 40% concentration favoured the plant growth and increased the root and shoot length and biochemical contents. This may be attributed to the optimum levels of inorganic nutrients and reduction in toxicity level due to dilution. Thus the effluent after diluting up to 40% can be used for irrigation as soil fertilizers for the better growth, biochemical and yield of maize. In the beneficial effluent concentrations, 20% was better than 40%.

Table 1 Physico chemical parameters of sugar factory effluent

Parameters	Value
Colour	Brown
Odour	Decaying smells
Temperature	35
Suspended solids	490
Ph	6.2
EC ($\mu\text{S cm}^{-1}$)	1.0
DO	10.3
BOD	2769.0
COD	4830.0
TS	1329.0
TDS	2480.0
Chloride	789.0
Alkalinity	134.0
Hardness	900.0
Calcium	480.0
Magnesium	524.0
Sulphate	374.95
Phosphate	23.0
Iron	0.08
Oil and Greece	23.0

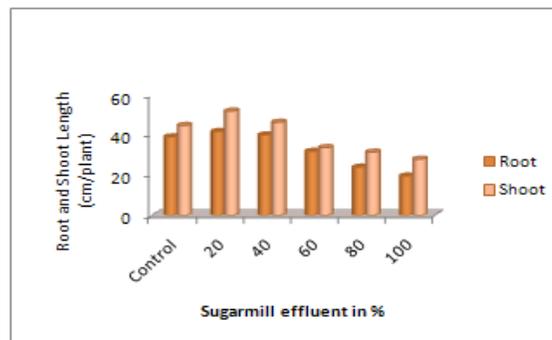


Fig:1 Effect of sugar mill Effluent in root and shoot length of maize on 30th days

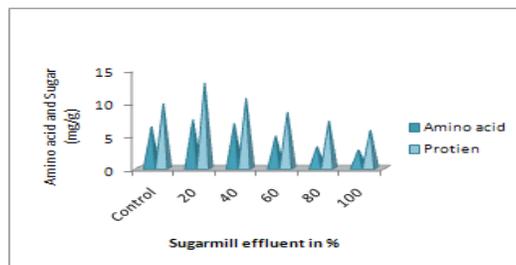


Fig:2 Effect of sugar mill Effluent in amino acid and protein contents of maize on 30th days

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