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Research Article

GROWTH AND PHYSIOLOGICAL ACTIVITY OF *Abelmoschus esculentus* L. UNDER EFFLUENT STRESS

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Abstract

The present research work has been carried out to understand the effect of different concentrations of Sugar mill effluent on growth, yield, biochemical contents and enzymatic activities of Bhendi (*Abelmoschus esculentus* L.). The increasing pace of industrialization in public and private sectors along with urbanization, population explosion and green revolution are reflected in varying degree of pollution of water, soil and air. The sugar mill effluent is having a higher amount of organic and inorganic elements. The physico-chemical analysis showed that it was acidic in nature and yellowish in colour. It was rich in total suspended and dissolved solids with large amount of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The higher amount of chloride, calcium, magnesium, sodium, potassium and iron were also present in the effluent. The effluents severally affect crop plants and soil properties when used for irrigation. Pot culture experiments were conducted with Bhendi at different concentrations of Sugar mill effluent. The growth parameters such as, shoot length, root length, fresh weight (FW), dry weight (DW) and leaf area were measured at 15, 30, 45 and 60 Days After Sowing (DAS). The pigment analysis *viz*., chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid contents were analyzed at 7 to 90 DAS. The yield parameters of Bhendi plants were recorded at the time of harvest. All morphological growth parameters, chlorophyll contents, and yield parameters were found to increase at 10 % effluent concentration and it decreased from 25 % effluent concentration onwards. So, these results reflect that the Sugar mill effluent is toxic to crop and it can be used for irrigation purpose after a proper treatment with appropriate dilutions.

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Key words: Sugar mill effluent, *Abelmoschus esculentus***,** Growth, Biochemicals, Antioxidant enzymes and Yield.

1. Introduction

Industrialization is an important tool for development of any nation. Consequently, the industrial activity has expanded so much all over the world. Today, it has become a matter of major concern in the deterioration of the environment (Tiwari, 1993).

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With the rapid growth of industries (sugar, paper, tannery, textile and dye industries) in the country, pollution of natural water by industrial waste water has increased tremendously (Amathussalam, 2002). Among them, sugar industry plays a major role in producing a higher amount of water pollution because they contain large quantities of chemical elements. They are solids, biological oxygen demand, chemical oxygen demand, calcium, magnesium, sodium, iron and sulphate.

The effluent not only affects the plant growth but also deteriorate the soil properties when used for irrigation (Maliwal, 2004). In addition to that, some traceable amount of heavy metals such as zinc, copper and lead were also present in the effluent (Borale, 1895). In arid and semi-arid regions of our country where shortage of water becomes limiting factor in agriculture, the effluent mixed polluted water is used for irrigational purposes by farmers (Singh, 1985). As this polluted water is being used for irrigation to cultivate the crops, it is necessary to conduct experiments to find out the impact of these effluents on agricultural crops before they are recommended for irrigation. The research work on growth and yield of crop plants is very rare so, the present investigation. The present research deals with the impact of sugar mill effluent irrigation on germination, growth, biochemical contents and enzyme activities and yield of *Abelmoschus esculentus.*

2. MATERIALS AND METHODS

Collection of Effluent and Seed Materials:

Sugar mill effluent samples were collected from the point of discharge of sugar factory situated in Tamil Nadu, India. The effluent sample was collected in plastic containers and stored in refrigerator. The effluent was analyzed for its various physico-chemical parameters as per the method of APHA (APHA, 1992). The seeds of *Abelmoschus esculentus* were procured from Department of Vegetable crops, Tamil Nadu Agricultural University, and Coimbatore, India. The surface sterilized green gram seeds were especially arranged in earthen pots containing five kg of garden soil. The various concentrations (10, 25, 50, 75 and 100 %) of sugar mill effluent solution were prepared and used for both laboratory and field culture studies. The Agricultural field was irrigated with equal volumes of various concentrations of sugar mill effluent. Control set was irrigated with equal volume of bore-well water. The morphological parameters and biochemical contents were analyzed at 15 days intervals five plants were collected from each treatment and they were analyzed for their morphological parameters, such as shoot length, root length, total leaf area, fresh weight and dry weight of the crop plant. Fresh weight (g/plant) was taken with the help of an electrical single pan balance. The collected plant materials were kept in hot air oven at 80 °C for 24 hours and their dry weight (g/plant) were taken by using an electrical single pan balance.

The leaf area was calculated by measuring the length and breadth of the leaf was described by Yoshida (1972).

$$\text{Leaf area (cm}^2\text{)} = K \times \text{length} \times \text{breadth}$$

Where, K = Kemp's constant (for dicot leaves = 0.66). Plant samples were taken at the time of harvest for the observation of the yield parameters such as number of fruit plant.

Estimation of Chlorophyll (Arnon, 1949)

Five hundred mg of fresh leaf material was taken and ground with help of pestle and mortar with 10 ml of 80 % acetone. The homogenate was centrifuged at 800 rpm for 15 minutes. The supernatant was saved. The residues were reextracted with 80 % acetone. The supernatant was saved and utilized for chlorophyll estimation. Absorbance was read at 645, 663 and 480 nm in the UV-spectrophotometer.

$$\text{Chlorophyll 'a' (mg g FW)} = (0.0127) \times (\text{OD } 663) - (0.00269) \times (\text{OD } 645)$$

$$\text{Chlorophyll 'b' (mg g FW)} = 0.229) \times (\text{OD } 645) - (0.00488) \times (\text{OD } 663)$$

$$\text{Total Chlorophyll (mg g FW)} = (0.0202) \times (\text{OD } 645) + (0.00802) \times (\text{OD663})$$

3. Results and Discussion

In field experiment, the shoot and root lengths were measured at different stages of the growth of (*Abelmoschus esculentus* L.) and are presented in Figure – 1.1 and Figure – 1.2. The higher shoot and root lengths were recorded at 10 % effluent concentration. The root and shoot length were adversely affected by higher concentrations of sugar mill effluent treatment. A gradual decrease in these growth parameters was observed. The same findings were reported earlier due to effluent treatment by Hariom *et al.* (1994). The reduction in shoot and root growth at higher concentration of effluent may be due to the fact that germinating seeds under higher concentrations would get less amount of oxygen which might have restricted the energy supply and retarded the growth and development by Kumar (2000). The effluent toxicity was manifested by the hard texture, hypertrophy of seedling, as well as browning and impairment of the root system. The higher toxicity was more pronounced in seedling at higher concentrations effluent (Behera, 1980). The Fresh weight (FW) and Dry weight (DW) of plant samples grown in various concentrations of effluent were presented in Figure - 2.1 and Figure - 2.2. The FW and DW were also increased at lower concentrations and decreased at the higher concentrations of sugar mill effluent. The presence of optimum level of nutrients in the lower concentrations of sugar mill effluent might have increased the FW and DW of crop plants. The reduction in dry weight of plant materials may be due to the poor growth under effluent irrigation by Balashouri *et al*. (1994).

The Figure - 3 shows that there was a significant increase in total leaf area of *Abelmoschus esculentus* plants at 10 % concentration of sugar mill effluent irrigation. At the same time, leaf areas were reduced in higher concentrations of effluent. It may be due to the reduced cell size and decreased intercellular spaces were largely responsible for reduction in leaf area due to effluent toxicity (Dutta and Biossaya, 1999). The yield parameters such as number of fruits per plant, number of seeds per fruits and their economic yield was higher at 10 % effluent concentration (Figure - 4). The high yield of plants at lower concentrations might depend on the enhanced low biosynthesis of pigments, carbohydrates and proteins (Yoshida, 1972). Present observation of increase and decrease in yield parameters also matches with the similar findings of Rajesh Kumar and Bhargava (1998).The findings of the present study reveals that the sugar mill effluent at lower concentrations promotes the growth and yield but the higher concentrations reduced the same though phytotoxic nature of effluent. The effluent invariability contains acids, alkalis, organic, inorganic salts, heavy metals and toxic elements which enter the plant body and disturb indigenous system, often producing detrimental effect (Singh, 1985). The decrease in shoot length, root length, fresh weight, dry weights and total leaf area and yield were recorded 25 % concentrations of effluent irrigation. It may be the presence of toxic pollutants in the effluent. That kind of pollutants mainly affects the respiration of the root. Respiration of root and soil organism tends to reduce the oxygen and increase the CO_2 concentration. The soil becomes harder and closed the pores of the soil are closed causing less aeration and retarding the growth of plant (Sing, 2005). Chlorophyll estimation is one of the important biochemical parameters which were used as the index of production capacity. The chlorophyll ‘a’, chlorophyll ‘b’, total chlorophyll and carotenoid content were analyzed at 7 DAS to 90 DAS. The 10 % dilution of sugar mill effluent concentrations increased the chlorophyll and carotenoid concentrations increased the chlorophyll and carotenoid elements present in the effluent on pigment system (Srivastava, 1999). Reduction in chlorophyll content induced by higher concentrations of effluent may be associated with mineral ions (Dutta, 1999; Pragasam, 2001). The similar result was observed in the changes induced by the effluent stress (Behera, 1980). From this observation, it can be inferred that at lower effluent concentration, the reserve food material has been efficiently utilized for growth and development of seedling. The lesser sugar content was recorded in the crop at higher effluent concentrations of effluent treatments from 10 to 100 per cent concentration. The decrease at higher concentration may be due to the excessive nitrogen uptake caused imbalance between nitrogen uptake and assimilation and a large supply of nitrogen might eventually lead to depletion of carbohydrate reserve.

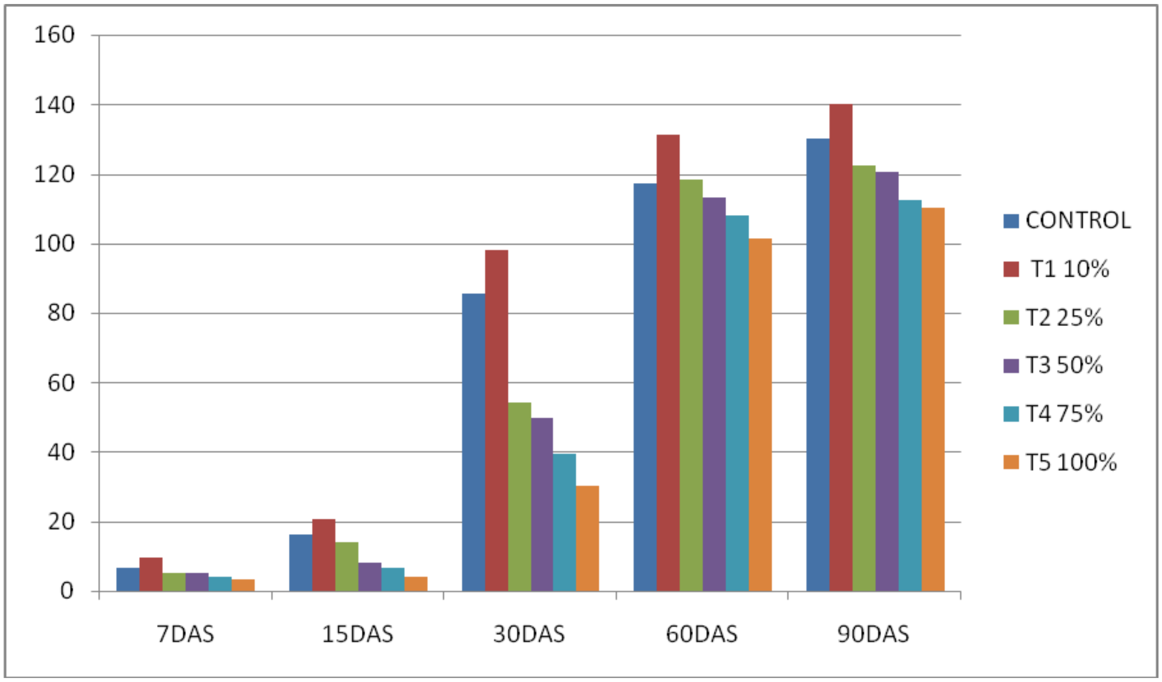

Figure – 1.1: Shoot Length

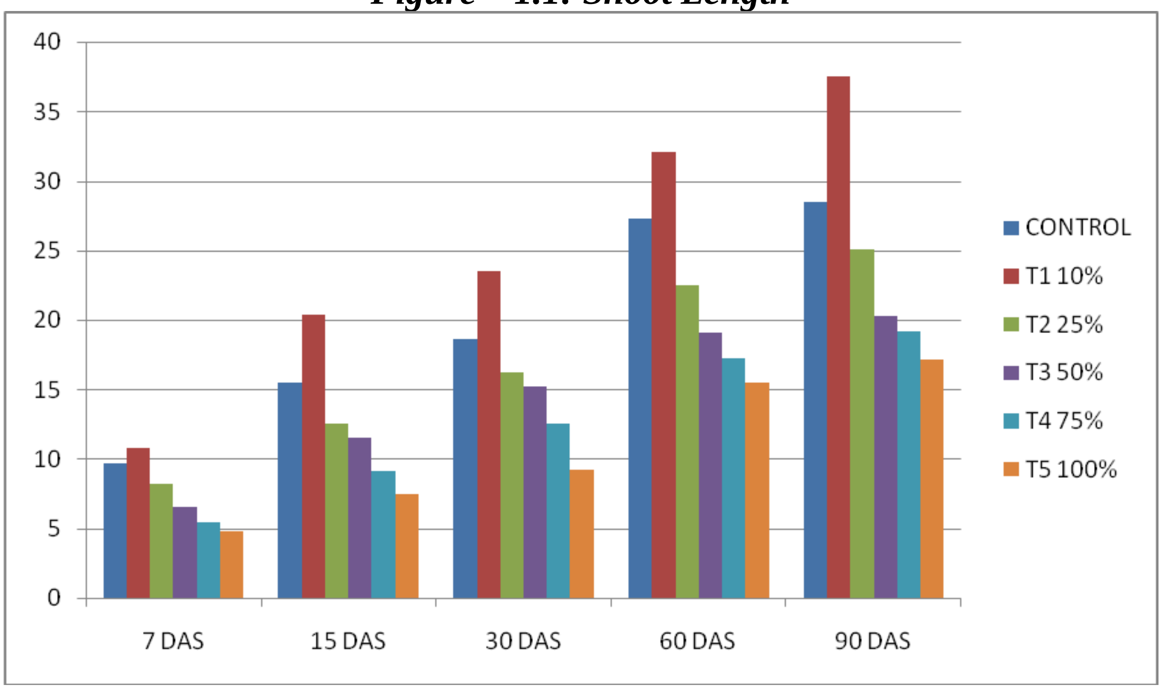

Figure – 1.2: Root Length

Figure – 1: Effect of different concentrations of sugar mill effluent on shoot length and root length (cm plant) of Bhendi (*Abelmoschus esculentus* L.) at various stages of growth

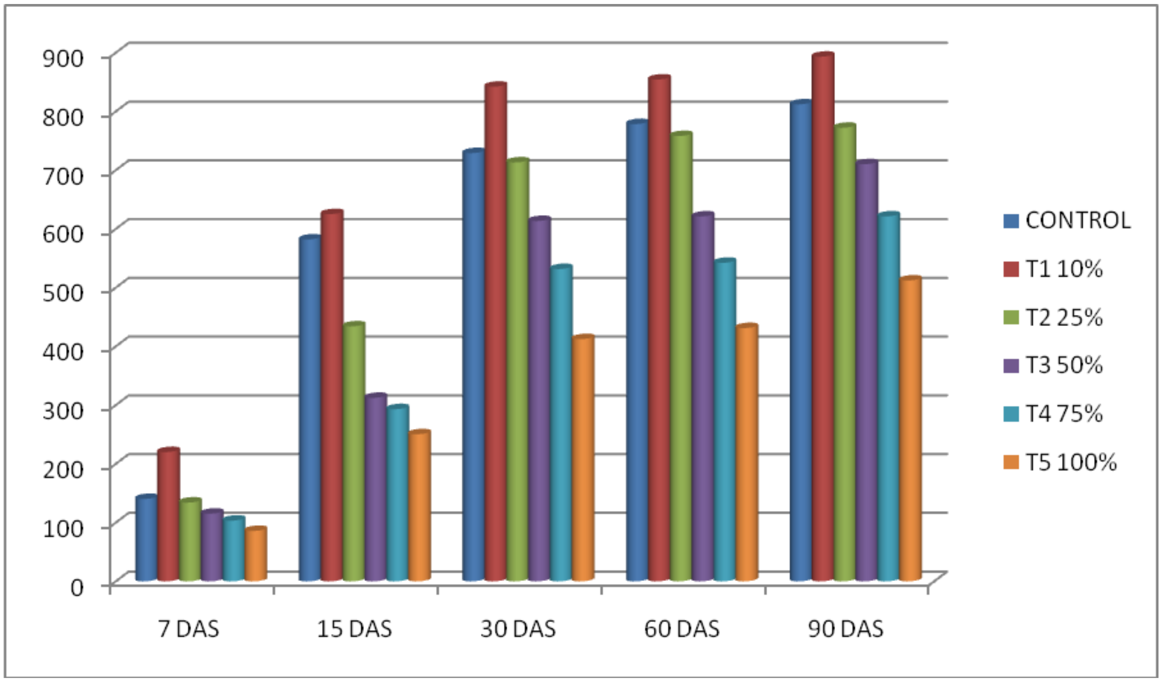

Figure – 2.1: Fresh weight

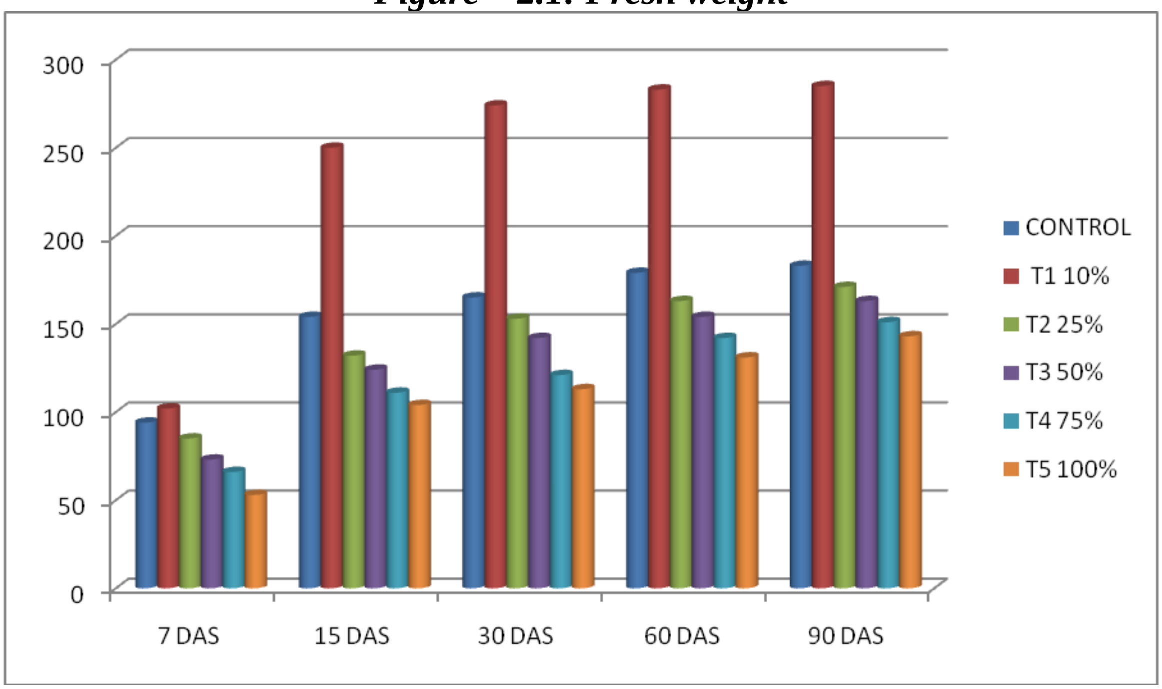

Figure – 2.2: Dry weight

Figure – 2: Effect of different concentrations of sugar mill effluent on Fresh weight and Dry weight (g plant of Bhendi) at various stages

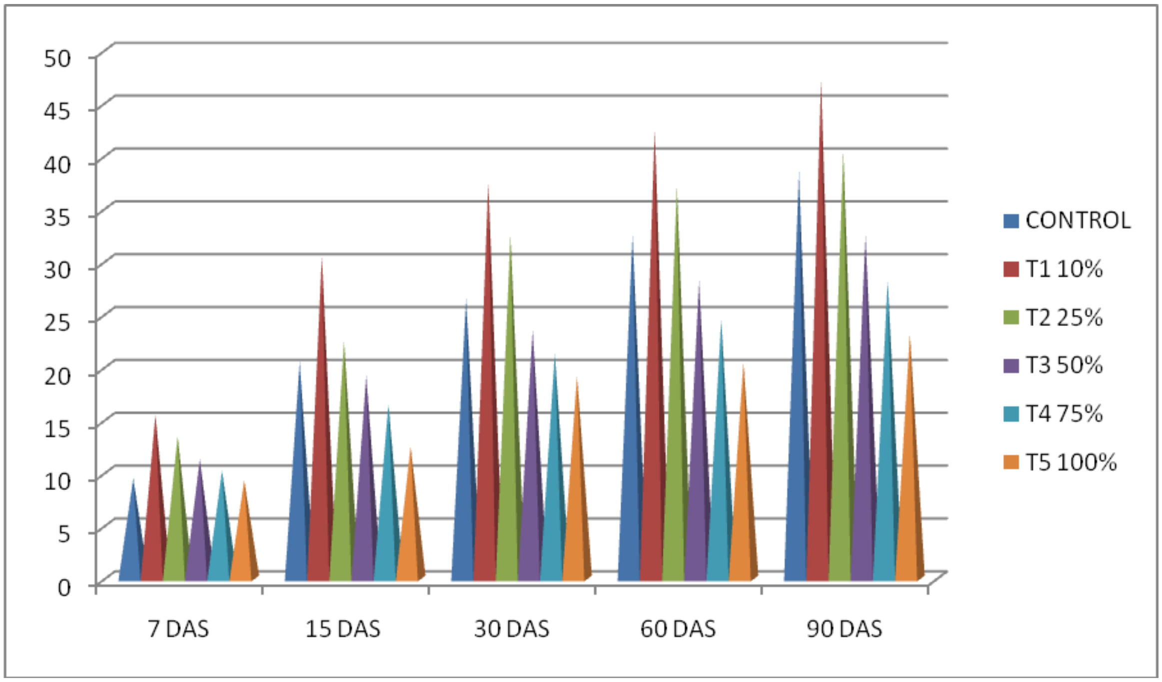

Figure – 3: Effect of different concentrations of sugar mill effluent on total leaf area (cm plant) of Bhendi (*Abelmoschus esculentus* L.)

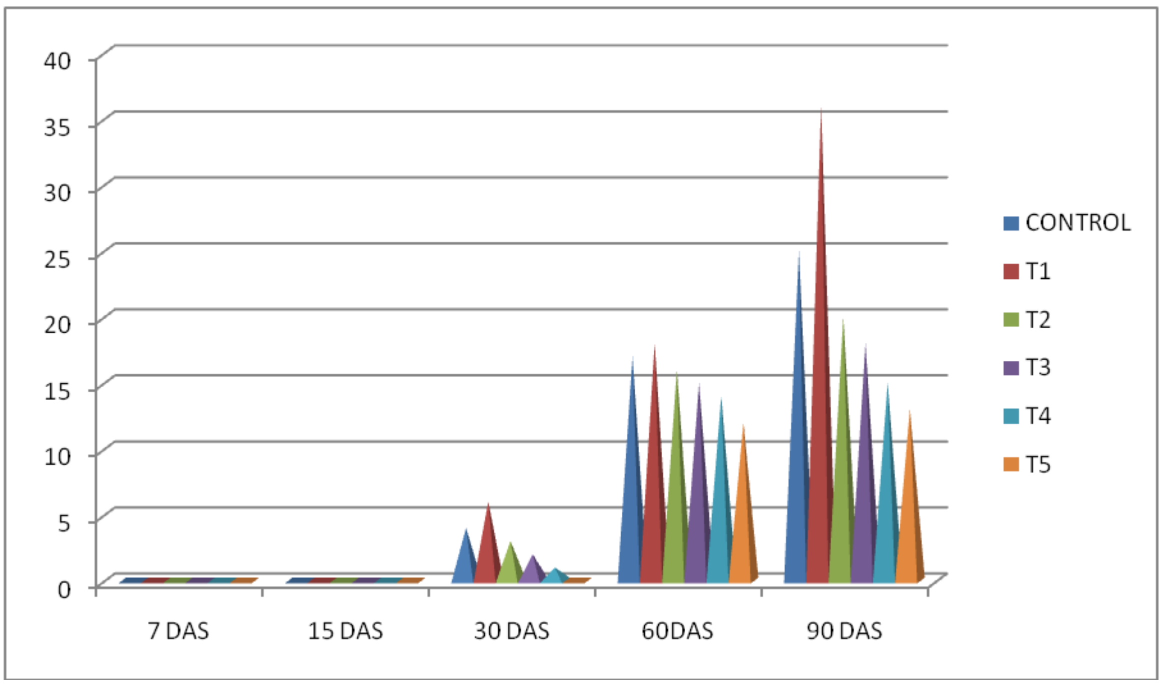

Figure – 4: Effect of different concentrations of sugar mill effluent on yield parameters of Bhendi (*Abelmoschus esculentus* L.) at harvest stages

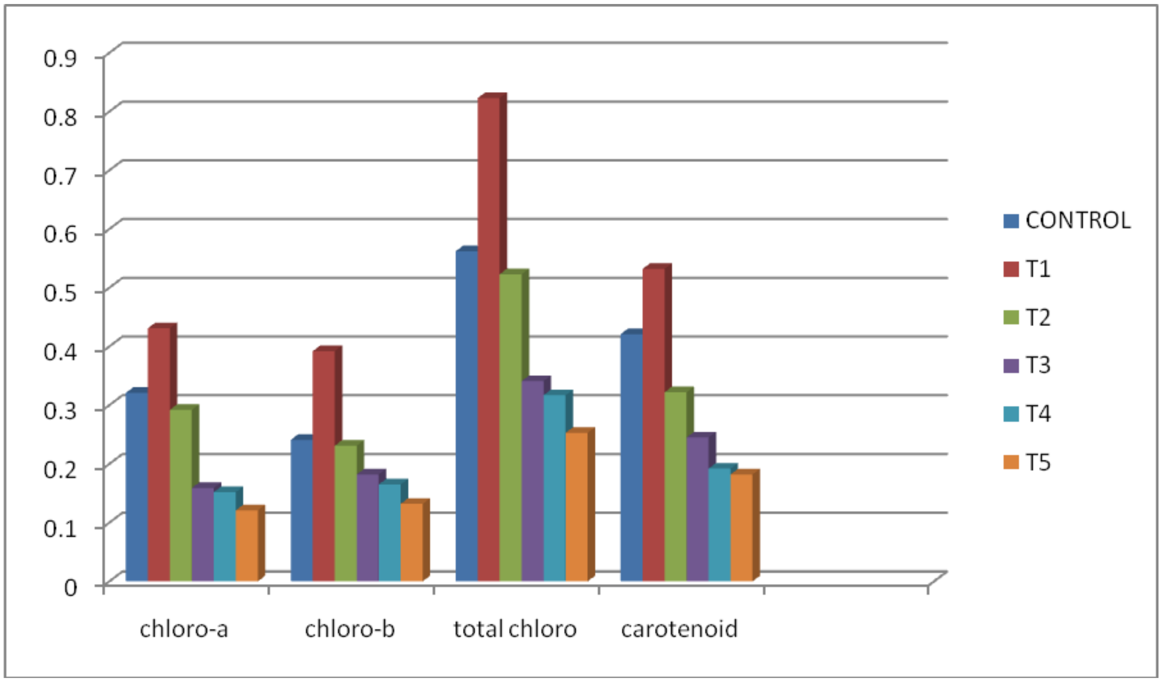

Figure – 5: Effect of different concentrations of sugar mill effluent on Chlorophyll contents of Bhendi (*Abelmoschus esculentus* L.) (mg\g F.W) at 7 DAS to 90 DAS

4. Conclusion

It can be fulfilled that the crude sugar mill effluent reduced the crop growth. However, the stimulation of growth and yield were observed at lower concentration of effluent. It is recommended that sugar mill effluent have to be diluted up to 10 % level before it is used for irrigation. After dilution, the effluent characteristics will become within the prescribed limits and contamination load of the effluent decreased. The effluent at lower (10 %) concentration can serve as a liquid fertilizer for the cultivation of agriculture.

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