Study of the morphological and histological studies of finger millet (*Eleusine coracana* (L.) Gaertn.) using sugar mill effluent

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ABSTRACT

Environmental pollution poses a great health hazard to living and non living substances. Industrial effluents, containing organic and inorganic compounds have strong influence on the development of growth of crop plants. A comparative study utilization of the sugar mill effluent on morphological and anatomical studies of the leaves and stems of *Eleusine coracana* was undertaken. The finger millet seeds were sown in soil-filled pots. Finger millet seedlings were irrigated with different sugar mill effluent concentrations control, 10, 25, 50, 75 and 100. Although high concentrations of sugar mill effluent decreased the growth, the low concentration (10%) of SME was very effective in increasing the growth of finger millet cultivars when compared with control. The T.S. of the root and leaf of *Eleusine* control plants at 90 DAS indicated uniseriate, thin walled epidermis. When the roots and leaf treatment control, 10 and 100 per cent of sugar mill effluent were considered, it was seen that the cortex area accumulated in some heavy hazards in 100% of sugar mill effluent. Industrial wastewater causes accumulation of heavy metals that are toxic in plants and thus affect the plant growth, seed germination, lower crop yield and human health. The adequate dilution of effluents treatment is therefore needed before the disposal and reuse of wastewaters for irrigation purposes. The anatomical studies showed that the lower, upper epidermis, cortex and the diameter of vascular bundles of root and leaves of finger millet reduced at the 100 per cent of effluent concentration, when compared to 10 per cent of effluent concentration. All the above mentioned parameters increased at lower (10%) concentration of the sugar mill effluent.

Keywords: Pollution, sugar mill effluent, Seed germination, anatomical studies.

1. INTRODUCTION

Sugarcane refinery is one of the most important agro-based industries in India and is highly welfare for creating a significant impact on rural economy, in particular and countries economy, in general. Sugar industries rank second among the agro-based industries in India. Sugar industry is seasonal in nature and operates only for 120 to 200 days in a year (Early November to April). The sugar industry requires about 1200 to 1400 m^3 of water and it is released as wastewater of sugar cane crushed. *Eleusine coracana* (L.) Gaertn (Finger millet) belongs to family Poaceae and is one of the most important cereals in the India. The poaceae is the fifth – largest plant family. The family poaceae is represented by 780 genera and 12000 species and distributed across and tropic and sub tropic regions. Finger millet is a high quantity of carbohydrate, proteins, calcium, and iron and the straw is also a nutritious feed for cattle. Finger millet is enriched in the essential amino acids like lysine [1] and methionine which are important in human health and growth but remain absent from most other plant foods. It is also rich in iron and fiber, making this crop more nutritive as compared to other most commonly used cereals. In addition, it also contains useful amounts of the two polyunsaturated fatty acids- linoleic acid and linolenic acid [2], metabolized products of which facilitate normal development of central nervous system [3]. It also contains water soluble and lipo soluble vitamins, thiamin, riboflavin, niacin and tocopherols [4]. The utilization of industrial effluent for irrigation of crop plants is one of the highly beneficial solutions for prevention of water pollution. The aims and objectives of research are to the utilize sugar mill effluent on finger millet (*Eleusine coracana* (L.) Gaertn.) Morphological and histological characters were analyze

2. MATERIALS AND METHODS

2.1. Collection of sugar mill effluent

The effluent samples were collected in a pre-cleaned plastic container from the point of disposal from a sugar mill Rajshree Sugar's Chemicals Limited located in Villupuram district of Tamil Nadu, India. The collected effluent was stored in a refrigerator at 4°C to maintain its original characteristics, and brought to the laboratory for the physico-chemical analysis purpose.

2.2. Cultivar

Eleusine coracana (Finger millet) seeds were obtained from Tamil Nadu Agricultural University (TNAU) in Coimbatore, Tamil Nadu and India. Uniformity was maintained regarding size, colour and weight for better interpretation.

2.3. Preparation of test solution

The collected effluent from the outlet of sugar mill effluent was considered as 100 per cent raw effluent. Different concentrations (Control, 10, 25, 50, 75 and 100%) of sugar mill effluent were prepared a fresh by using tap water, whenever necessary. They were used for both germination studies and pot experiments.

Control : Tap water
10% : 10 ml effluent + 90 ml of water 25% : 25 ml effluent + 75 ml of water 50%
: 50 ml effluent + 50 ml water
75% : 75 ml effluent + 25 ml water 100% : Raw effluent

2.4. Germination studies

Pot culture experiments were conducted with the *Eleusine coracana* L. seeds to find out impact of treated sugar mill effluent on growth and yield of (*Eleusine coracana*) five kg of garden soil was taken in a pot and ten seeds of were sown in each pot. The pots were irrigated with different concentrations of sugar mill effluent treatments twice in a week. The control set was maintained for tap water irrigated experiment. Five samples were randomly selected from each treatment and their morphological and anatomical studies were recorded harvest stage.

Experimental period : March 2016 to May 2016 sampling days : 30, 60 and 90 DAS
Replications : Three times
Sugar mill effluent : Control, 10, 25, 50, 75 and 100 per cent
Crop : Finger millet (*Eleusine coracana* (L.) Gaertn var. CO-13) Parameters
studied : Morphological and anatomical studies.

2.5. Anatomical structure of *Eleusine coracana*

At booting stage, roots from four plants for each line were taken and fresh adventitious roots of 8 cm length were selected. Permanent flakes of the roots were made after the process of fixing, flushing, softening, dyeing, dehydration, transparency, wax dip, embedding, slicing, sticking, spreading, baking, de waxing, re dyeing, rehydration and mounting [5].

For histological studies, only 4 leaves and roots from the middle part of finger millet plant were taken up for consideration. The plant materials were fixed in formalin/ethanol/acetic acid/water (FEA; 4:69:5:22 volume to volume) and conserved in 70% ethanol and conserved in ethylic alcohol 70%. Free hand cut sections were performed using a razor blade. The sections were stained with aqueous safranin to visualize the tissues. The photos were taken with an Olympus E-330 photo camera, using an Olympus BX51 research microscope. The measurements of the epidemial cells, stomata and assimilating parenchyma were made using biometrical software from Nikon (NIR-Demonstration). One section was investigated from each leaf; for each parameter 50 measurements were made. The following histological studies were measured: leaf thickness (LT), height of the palisade cells (HPC), the diameter of the spongy cells (DSC), height and width of the upper epidermis cells (in cross section) (HEP and WEP), midvein bundle, stomata length (SL) and stomatal index (SI) .

3. EXPERIMENTAL RESULTS

The present research work has been carried out on the utilization of sugar mill effluent on seed germination and anatomical studies.

3.1. Germination studies

The utilization of various concentrations of sugar mill effluent on seed germination percentage, root and shoot length, fresh and dry weight of finger millet is given in Table 1 and Figure 1.

Highest seed germination growth was observed at 10 per cent (100), when compared to the control values (98) of sugar mill effluent concentration. Further, increasing effluent concentration gradually decreased the seed germination. The seedling growth root and shoot length were increased at 10 per cent (5.74 & 12.10) when compared to control values (5.60 &12.07) of sugar mill effluent concentration. The highest fresh and dry weights were recorded at 10 per cent (1.00 & 0.14) when compared to control values (0.873 & 0.12) of sugar mill effluent concentration. But, increase in effluent concentrations gradually decreased the fresh and dry weight. The F values were found to be significant at $P < 0.05$, level.

Table 1. The efficacy of sugar mill effluent on germination, root and shoot length, fresh and dry weight of finger millet (*Eleusine coracana* (L.) Gaertn.) on 15th day seedlings

Effluent Conc. (%)	15th day seedlings				
	Germination percentage	Root length (cm plant^{-1})	Shoot length (cm plant^{-1})	Fresh weight (g. fr. wt.)	Dry weight (g. dr. wt.)
Control	98	5.60	12.07	0.87	0.12
10	**100 ± 1.54**	**5.74±0.205**	**12.10±0.200**	**1.00±0.202**	**0.14±0.406**
25	96 ± 1.22	4.50±0.161	11.00±0.158	0.623±0.160	0.13±0.032
50	75 ± 1.09	4.02±0.145	9.49±0.142	0.503±0144	0.11±0.028

75	64 ± 0.98	2.35±0.131	7.02±0.128	0.38±0.129	0.10±0.025
100	35 ± 0.88	0.24±0.117	5.25±0.115	0.173±0.116	0.023±0.01

± Standard Error

3.2. Histological Structure Root and Leaf of Finger Millet (*Eleusine Coracana* (L.) Gaertn.) Under the Sugar mill effluent

In microscopic view, histological characteristics are shown in transverse sections through the median of the midrib leaf of finger millet plants grown under different concentration of sugar mill effluent. Likewise, microphotographs illustrating these treatments and the untreated plants are shown in transverse section in the leaf thicknesses of the epidermis, Hypodermis thickness, diameter of the spongy cells and vascular bundle thickness were decreased in treated plants compared with the control. Histological characters in transverse sections of finger millet leaf and root (*Eleusine coracana* (L.) Gaertn.) grown under the different concentration of sugar mill effluent in given Table 2 and 3.

Table 2. Histological characters in transverse sections through the median portion of the leaf of finger millet (*Eleusine coracana* (L.) Gaertn.) grown under the different concentration sugar mill effluent

Histological character	Treatments		
	Control	**10%**	**100%**
Leaf thickness	45.80 ± 1.37	35.00 ± 1.05	15.20 ± 0.45
Epidermis thickness	25.30 ± 0.75	32.5 ± 0.97	18.95 ± 0.56
Hypodermis thickness	35.34 ± 1.06	37.25 ± 1.11	20.00 ± 0.6
Diameter of the spongy cells	220 ± 6.6	236 ± 7.08	215 ± 6.45
Vascular bundle thickness	125 ± 3.75	138 ± 4.14	85 ± 2.55

± Standard Error

The T.S. of the root of *Eleusine* control plants at 90 DAS indicated uniseriate, thin walled epidermis. The cortical parenchyma cells are homogeneous, oval, thin walled. The endodermis was the innermost layer. The stele includes central core of vascular tissues. When the roots of treatment control, 10 and 100 per cent were considered, it was seen that the cortex area accumulated in some heavy hazards. The T. S. of root and leaf at 30, 60 and 90 DAS effluent treatments also showed some amount metals accumulation. Similar accumulation was also noticed in the treatments on 30, 60 and 90 DAS (Figure 2 and 3).

Table 3. Histological characters in transverse sections through the median portion of the root of finger millet (*Eleusine coracana* (L.) Gaertn.) grown under the different concentration sugar mill effluent

Histological character	Treatments		
	Control	**10%**	**100%**
Root thickness	30.00 ± 0.90	32.25 ± 0.96	27.29 ± 0.81
Epidermis thickness	14.35 ± 0.43	15.98 ± 0.47	12.88 ± 0.38
Hypodermis thickness	27.50 ± 0.82	32.88 ± 0.98	11.25 ± 0.33
Mid rib thickness	95.32 ± 2.85	125.30 ± 3.75	82.11 ± 2.46
Vascular bundle thickness	135 ± 4.05	148 ± 4.44	122 ± 3.66

± Standard Error

FIGURE 1

GERMINATION STUDIES – GROWTH OF *Eleusine coracana* SEEDLINGS (Var. CO-13) UNDER DIFFERENT CONCENTRATIONS (CONTROL, 10, 25, 50, 75 and 100%) OF SUGAR MILL EFFLUENT

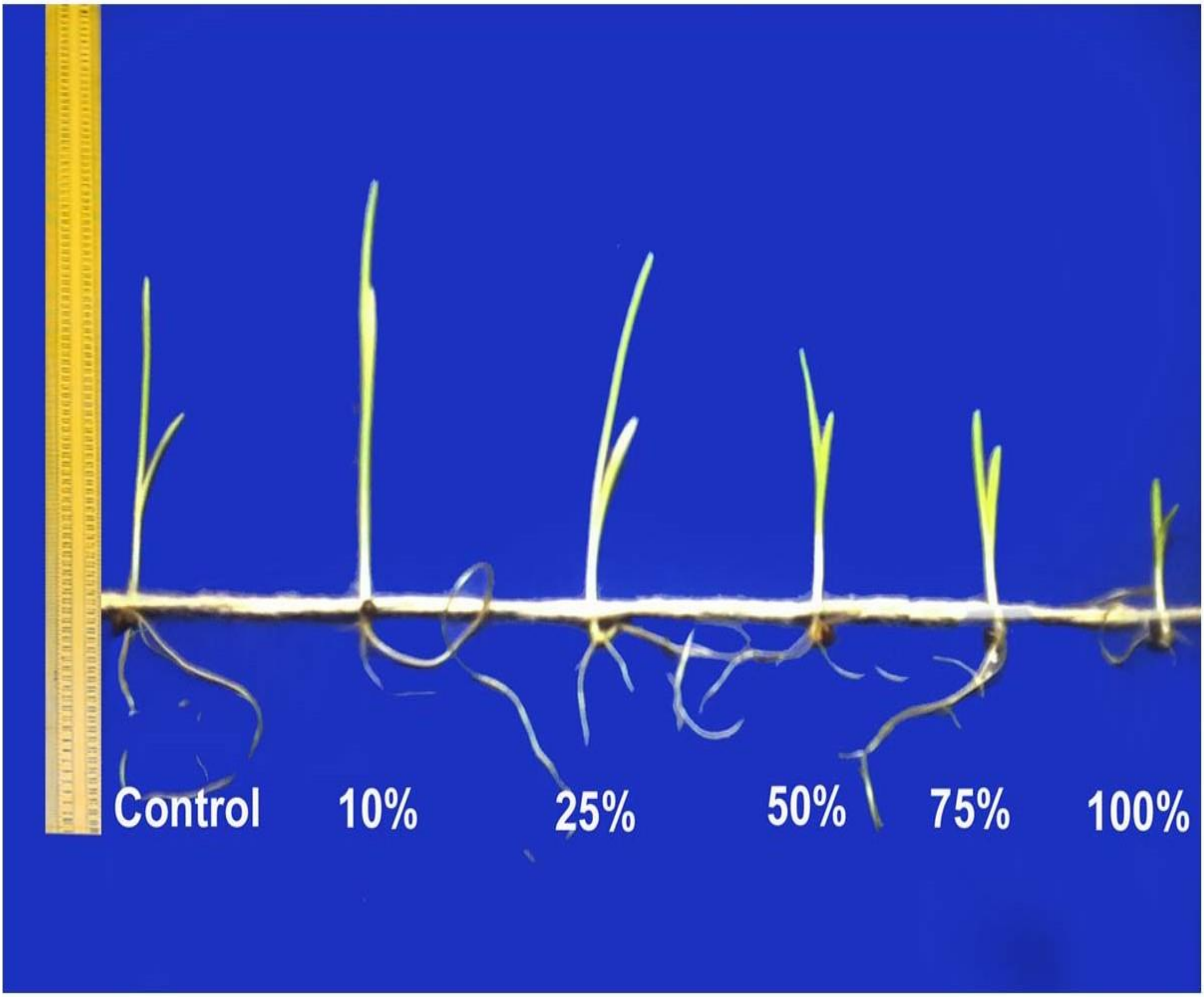


FIGURE 2

HISTOLOGICAL STRUCTURE OF *Eleusine coracana* LEAF UNDER THE DIFFERENT CONCENTRATIONS (CONTROL, 10 AND 100%) SUGAR MILL EFFLUENT AT 90 DAS

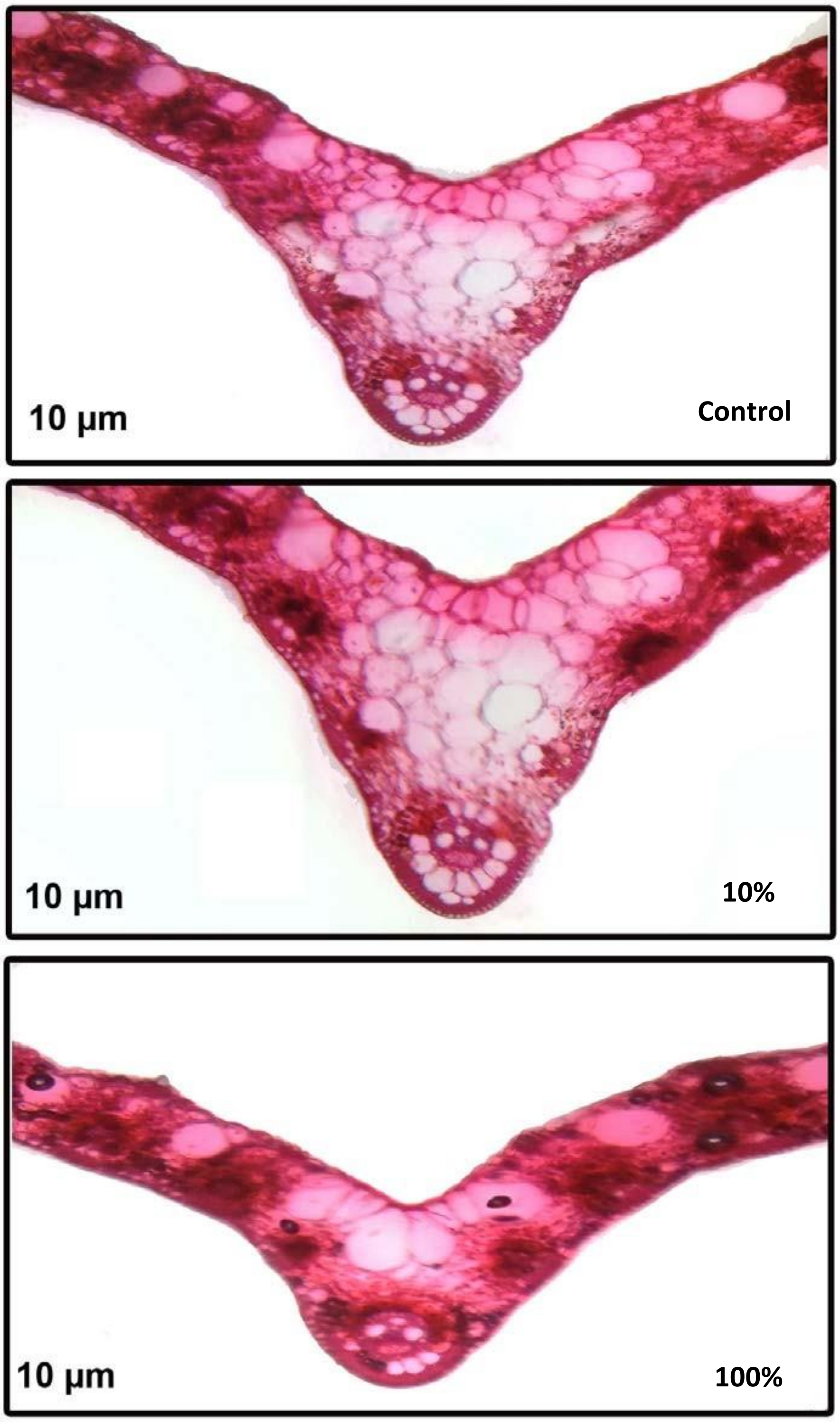
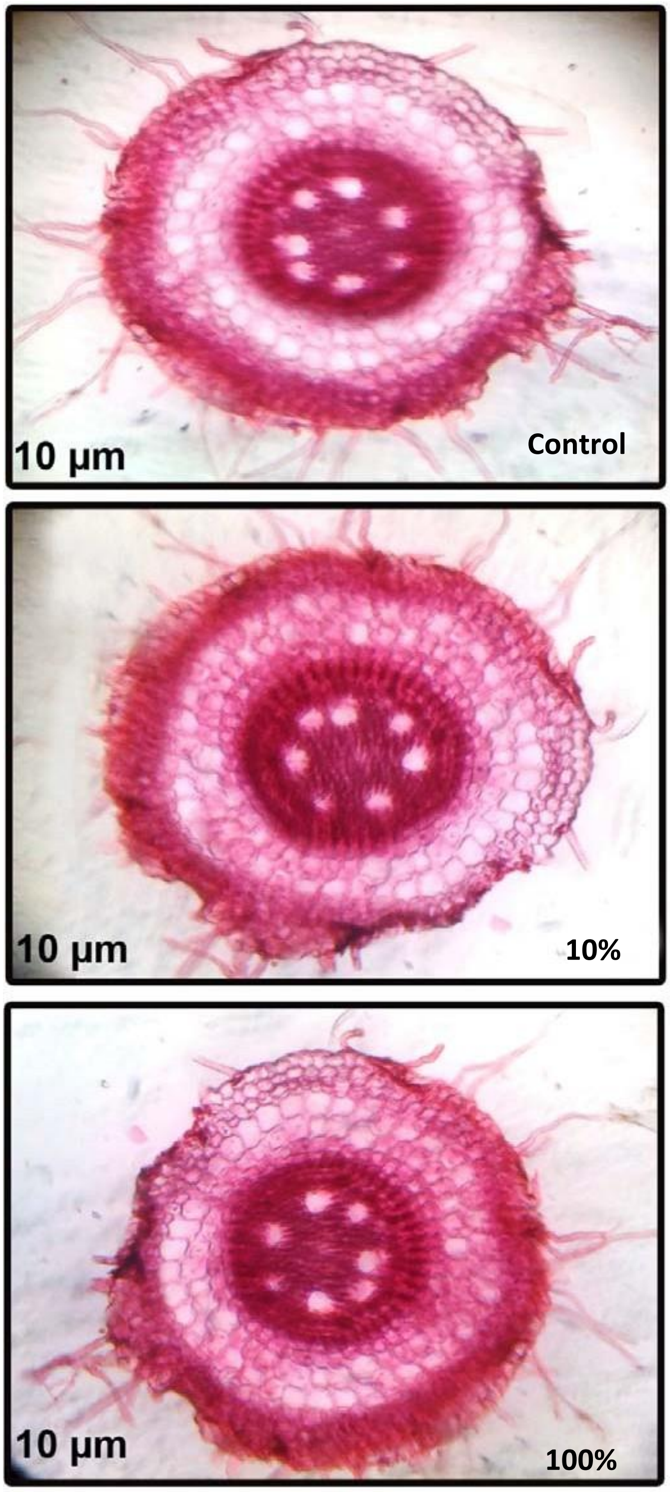


FIGURE 3

HISTOLOGICAL STRUCTURE OF *Eleusine coracana* ROOT UNDER THE DIFFERENT CONCENTRATIONS (CONTROL, 10 AND 100%) SUGAR MILL EFFLUENT AT 90 DAS



CONCLUSION

From this experiment, the industrial effluents could be well utilized for agricultural crops on proper dilution, so as to reduce the lethality of the pollutants. The sugar mill effluent can be used for irrigation purposes after proper dilution for the maximum yield of this crop and to maintain soil health and healthy environment. In the reviewed work, it may be concluded that diluted concentrations of sugar mill effluent could be used as a liquid fertilizer in low concentration is ideal for the better growth and yield of finger millet.

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