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Comparative Analysis of Some Physiological Parameters of Bioindicator Plants (*Amaranthus & Chenopodium*)

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ABSTRACT

Bioindicator plants play a crucial role in environmental monitoring due to their sensitivity to various pollutants and environmental stresses. In this study, a comparative analysis of several biological parameters of two commonly used bioindicator plants, *Amaranthus* and *Chenopodium* was made. The aim was to evaluate their suitability for environmental monitoring and determine any significant differences between the two species. *Amaranthus* and *Chenopodium* plants were grown under controlled conditions and exposed to varying concentrations of pollutants, including heavy metals and air pollutants. Several biological parameters, including growth rate, leaf area, chlorophyll content, and antioxidant enzyme activity, were measured and compared between the two species. The results indicated that both *Amaranthus* and *Chenopodium* exhibited sensitivity to the tested pollutants, as evidenced by changes in their biological parameters. Significant differences were observed between the two species in terms of their response to specific pollutants and their overall tolerance levels. For instance, Chenopodium showed higher tolerance to heavy metal stress, while Amaranthus exhibited greater sensitivity to air pollutants. Thus, it can be said that both *Amaranthus* and *Chenopodium* can serve as effective bioindicator plants for environmental monitoring purposes. However, the choice between the two species should be based on the specific pollutants and environmental conditions of the monitoring site. Further research is warranted to elucidate the underlying mechanisms responsible for the observed differences between these bioindicator plants and to refine their use in environmental assessment and management strategies.

Key Words: *Amaranthus,* Bioindicator plants, Biological parameters, Biomass accumulation, *Chenopodium*, Chlorophyll Content, Environment, Enzyme, Growth rate, Leaf area, Monitoring.

INTRODUCTION

Bioindicators are sensitive to a variety of environmental stresses and pollutants and have become important tools in environmental monitoring. These plants are useful indicators of the quality and health of the environment because they can adapt their biological parameters to reflect changes in their surroundings. *Amaranthus and Chenopodium* species are two of the many varieties of bioindicator plants that have attracted a lot of attention due to their use in environmental monitoring research. *Chenopodium* and *Amaranthus* are both good options for evaluating environmental conditions because of their traits like rapid development, extensive dispersal, and sensitivity to contaminants. Many studies have shown how effective *Chenopodium* and *Amaranthus* are at identifying pesticides, heavy metals, and other contaminants in soil and water (Khan *et al,* 2019; Agnihotri *et al,* 2020). Furthermore, these plants have been used to measure air pollution, especially in cities where industrial operations and vehicle emissions worsen the environment (García-González *et al,* 2018; Chawla *et al,* 2021).

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The main objective of the study was to examine and contrast several important biological characteristics between Chenopodium and Amaranthus under carefully monitored circumstances. Growth rate, biomass accumulation, leaf area, chlorophyll content, and antioxidative enzyme activity were few of these parameters. It is vital to comprehend the disparities in the biological reactions of these bioindicator plants to ensure their efficient application in environmental monitoring initiatives. Therefore, this investigation will shed light on how well-suited and useful *Chenopodium* and *Amaranthus* are as bioindicators for determining pollution levels and environmental quality.

MATERIAL AND METHODS

Two different species, *Amaranthus* (dhimbdo) and *Chenopodium* (goosefoot), were chosen and gathered from various areas within Bhiwani. These plant samples were randomly selected and assembled fresh inside aluminium foil to keep moisture from evaporating. It was sent straight away to the lab for identification before being refrigerated. To prevent fluctuations in the results, samples of every leaf were taken within a day of one another.

Total chlorophyll content

In a 15 mL centrifuge tube, 10 mL of freshly made 80% acetone was combined with 1 g of powdered fresh leaf sample to estimate the total chlorophyll concentration. After achieving complete separation, the leaf extract was centrifuged at 2500 rpm for 180 seconds and then transferred into test tubes using Whatman filter paper. Using an ultraviolet spectrophotometer, the solution absorbance was then measured at 645 and 663 nm in accordance with the ARNON method (Lichtenthaler & Welburn, 1983) after calibration using 80% acetone as the reagent blank.

$$\text{Chlorophyll a} = 12.7 \times A(663) - 2.69 \times A(645) \times \frac{V}{1000 \times W}$$

$$\text{Chlorophyll b} = 22.9 \times A(645) - 4.68 \times A(663) \times \frac{V}{1000 \times W}$$

where V is the sample extract volume (mL), W is the leaf weight (g), and A645 and A663 are the absorbances at 645 and 663 nm, respectively.

Ascorbic acid content

A muslin cloth filter was employed for the juice. 10 ml (W) of juice were pipetted into a 100-ml volumetric flask, and the volume (V_1) contained one milliliter of oxalic acid solution. Someone gave the flask a good shake. Following the juice's filtration, a standard dye (V) solution was titrated against a known quantity (V_2) of solution until a colour emerged that persisted for 15 seconds. The ascorbic acid quantity was determined using the formula (Keller and Schwager, 1977).

Relative water content

The fresh leaves were first weighed to measure their relative water content. They were then promptly immersed in water for 24 hours, blotted dry, and reweighed to estimate their turgid weight. The turgid leaves were then oven-dried for 12 hours at 70 °C, and the dry weight was measured using the procedure outlined by Singh (1977).

$$\text{RWC (\%)} = \frac{(\text{Fresh weight} - \text{Dry weight})}{(\text{Turgid weight} - \text{Dry weight})} \times 100$$

RESULTS AND DISCUSSION

Ascorbic Acid

Amaranthus (13.38 mg/g) and Chenopodium (12.5 mg/g) had high ascorbic acid content in the control site, while the polluted site showed a range of 10.9 mg/g (Amaranthus) to 11.8 mg/g (Genus Chenopodium). This and other plant species' lower ascorbic acid content in their leaves confirms how sensitive these plants are to air pollution (Jyothi and Jaya, 2010). The antioxidant qualities of ascorbic acid, which are found in portions of plants that are actively growing, affect a plant's ability to withstand air pollution. Ascorbic acid is consumed during the removal of the cytotoxic radicals generated in response to pollutants that penetrate the leaves, so a decrease in ascorbic acid content is indicative of a decline in the plant defence systems. Conversely, an increase

S. No.	Name of the Zone	Location in the city
Site-A	Bhiwani textile mill	Industrial area
Site-B	Railway station yard	North of city
Site-C	Bus stand yard	HQ region
Site-D (Control site)	Chaudhary Bansi Lal	Campus area

in ascorbic acid levels is associated with increased levels of pollution resistance (Lima *et al,* 2000). Ascorbic acid was found to be more at the control site in both genotypes but only a slight change was observed in the concentration of ascorbic acid at the polluted site as well.

Chlorophyll Content

The genotypes showed purposeful differences in total chlorophyll content in both the polluted and control sites. The Amaranthus showed less chlorophyll content as compared to the controlled site. Maximum chlorophyll content was found in SITE-D and the minimum at SITE-A. The decreased value in chlorophyll content seems to be directly related to the increasing pollution load. There was a major variation within the chlorophyll content in both sites. The mean value of chlorophyll content in *Chenopodium* was equivalent at both sites respectively, whereas *Amaranthus* showed a large deviation in all selected sites.

The present study showed that chlorophyll content was found to be high at the control site as compared to the other three sites. In *Amaranthus* mean total chlorophyll content was found 4.5(mg/g) while in *Chenopodium* it was found to be 6(mg/g) whereas at the polluted site, this value decreased up to 2.5 to 3.5 (mg/g). Previous studies by Tripathi and Gautam (2007) reported similar results on chlorophyll estimation (Fig.1)

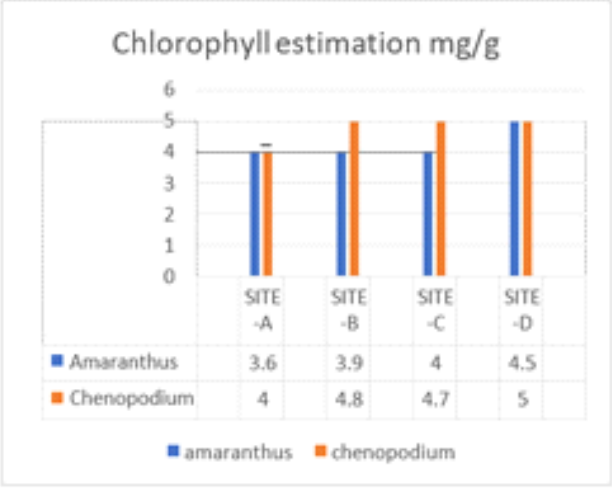

Fig.1 Effect of chlorophyll estimation polluted & control site

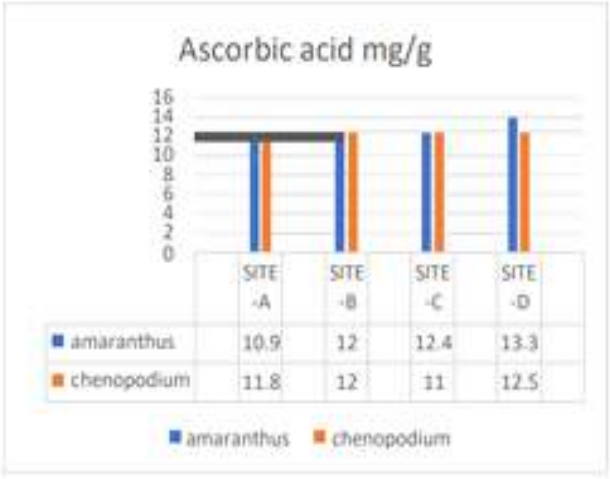

Fig 2. Effect of Ascorbic acid in polluted & control sites

There was a significant variation in ascorbic acid concentration in both genotypes (graph 12). The mean value of ascorbic acid analysis was higher in *Amaranthus* at control (SITE-D) whereas a slight deviation was observed in *Amaranthus* at other respective sites. The same observation was found in *Chenopodium (Fig.2.)*

Both plants showed informative variation in relative water content *i.e.,* maximum percent of relative water content was found at SITE-D and minimum at SITE-A while SITE-C & SITE-B showed the same percentage of water content in both genotypes (Fig.3). Relative water content considerably decreased under stress conditions. Most relative water content was determined in the *Amaranthus* genotype at the control site while the remaining sites showed almost equal amounts of water content in their respective leaf and a minimum was observed in *Chenopodium* at polluted SITE-A whereas the same amount of water content was found in both SITE-B & C

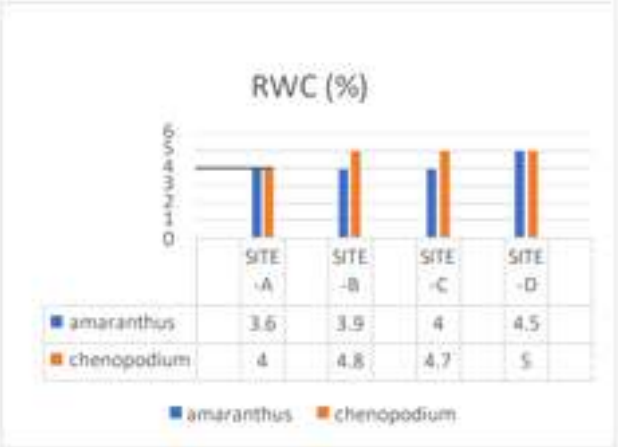

Fig 3. Effect of RWC, polluted & control sites

CONCLUSION

The present investigation aimed to check the impact of bio-indicator plants at polluted and control sites. It was concluded that pollution significantly affected vegetation and results revealed that the earlier researchers might have experienced several morphological and biological problems. When plants are continuously exposed to air pollution, they take in, accumulate, and digest the pollutants, which, depending on how sensitive they are, affect the structure of their leaves. In particular, these plants are highly recommended at polluted sites due to the possibility that they could act as sinks for air pollutants. These plants also seem to be sensitive to the atmosphere, which means that they could be used as effective bioindicators of pollution and help determine which species would be best to plant in the future at polluted sites.

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