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Seasonal Variation of Peroxidase Enzyme Activity in Agricultural crops under Paddy, Groundnut, Maize, and Red Gram Cultivation

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Abstract
This study analyzed peroxidase enzyme activity in different polluted and control soils in Warangal city from June 2019 to May 2020. Peroxidase activity ranged from 0.23 to 1.35 mg/g in soils near the paddy soils, 0.31 to 1.39 mg/g in soils amended with groundnut soils, 1.39 to 2.48 mg/L in maize soils, 0.21 to 1.29 mg/g in redgram soils, and 0.31 to 1.43 mg/g in control soils. These results indicate that agricultural soils enzyme activity, reflecting changes in soil biochemical properties.

Keywords: Peroxidase enzyme, Soil health,

Introduction

Peroxidase enzymes, belonging to the oxidoreductase family, are essential for both plants and soils. In plants, the catalyse enzyme breakdown of hydrogen peroxide (H_2O_2), a reactive oxygen species, and form a crucial part of the antioxidant safeguarding system alongside superoxide dismutase and catalase. Peroxidases enhance stress tolerance by mitigating oxidative damage caused by drought, salinity, heavy metals, and other environmental stresses (Gill & Tuteja, 2010; Sharma et al., 2012). They also contribute to lignification, suberization, cell wall cross-linking, pathogen safeguarding, auxin metabolism, and phenolic compound oxidation, influencing plant growth and development (Passardi et al., 2004) Tabatabai, M. A. (1994) Sinsabaugh, R. L. (2010) .

In soils, peroxidases originate from plant roots, microorganisms, and decomposing organic matter. They play a vital role in degrading complex organic molecules, such as lignin and phenolic compounds, and contribute to nutrient cycling, particularly carbon and nitrogen turnover (Nannipieri et al., 2011). Soil peroxidases are also involved in the detoxification of pollutants, including pesticides, textile dyes, and industrial effluents (Dube et al., 2010). Environmental factors such as p^H, organic matter content, temperature, and season influence soil peroxidase activity, which tends to increase under moderate stress or in soils enriched with organic waste (Alvarez et al., 2019; Ramesh et al., 2015) Sinsabaugh, R. L. (2010). .

Soils exposed to sewage or industrial effluents, such as those from dairy or tannery industries, exhibit variable peroxidase activity due to differences in organic load, pH, and microbial populations (Singh et al., 2013). Seasonal variations also affect enzyme activity, with higher levels in winter and rainy seasons due to optimal moisture and nutrient availability, and lower levels in summer due to reduced carbon content and alkaline p^H (Kumari & Rao, 2018). Peroxidase activity thus serves as a reliable bio indicator for assessing soil health, fertility, and the ecological impact of anthropogenic activities. Nannipieri, et al. (2012).

Materials and Methods

The soil solutions (1:5 soil and distilled water) were made and filtered through Whatsmann No. 42 filter paper and clear solution was used as soil enzyme extract.

Plants produce peroxidase enzyme during aerobic respiration which breakdown hydrogen peroxide to water and oxygen.Reagents : Guaicol (0.04 M) : 0.447 ml guaciol in 100 ml distilled water.Hydrogen peroxide (1%) : 1 ml of 30% H_2O_2 in 29 ml distilled water. Phosphate buffer (p^H 4.5) (a) Na_2HPO_4 – 0.089gms in 50 ml distilled water. (b) $NaHPO_4$ – 0.078 gms ml distilled water.Prepare the phosphate buffer on the day of use by mixing 50 ml of (a) and 50 ml of (b) solutions. One gm of fresh plant leaves were ground in 10 ml of phosphate buffer with pestle and mortar and centrifuged the plant material at 2500 rpm for 15 minutes. One ml of supernatant was taken as an enzyme source and added with 1.5 ml phosphate buffer followed by 1.5 ml guaicol. Reaction was initiated by adding 1.5 ml of hydrogen peroxide (1%). In the presence of peroxidase enzyme guaicol was oxidized to tetraguaicol which gave a brownish red colour. The developed colour was read at 468 nm for 2 minutes with 30 seconds time interval and the activity was expressed in enzyme units (increase in Optical Distilled water in 1.0 in one minute at 468 nm is equal to one unit).

Results and Discussion

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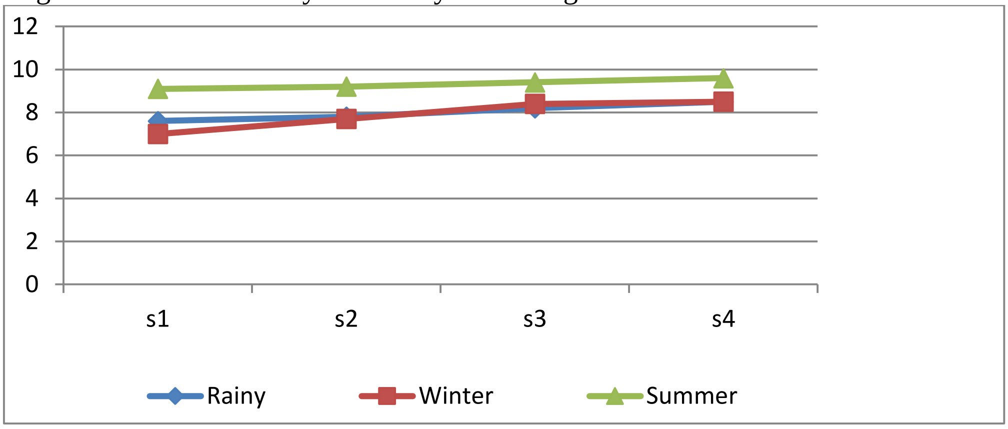
The study, conducted from May 2019 to January 2020, revealed significant seasonal variations in soil peroxidase activity. Black soils in Bhupalpally District are primarily used for paddy cultivation, while red soils used for groundnut, maize, and red gram. Soil p^H was generally neutral in winter and rainy seasons, becoming alkaline during summer. The agricultural crops particulars were given in table. Peroxidase enzyme activity expressed in agricultural soils given in figure.

S.No	Common name	Scientific Name	Family	Angiosperms
1	Paddy	Oryza sativa	Poaceae	Monocotyledon
2	Groundnut	Arachis hypogea	Fabaceae	Dicotyledon
3	Maize	Zea mays	Poaceae	Monocotyledon
4	Red gram	Cajanus cazan	Fabaceae	Dicotyledon

Figure 1: Peroxidase enzyme activity in four Agricultural soils



Recorded p^H values were available soil carbon was low in summer across all agroecosystems but ranged from medium to high during rainy and winter seasons. Maximum peroxidase activity was observed in soils amended with ground nut soils, while maize soils exhibited lower activity. Red gram soils showed moderate enzyme levels, reflecting baseline enzymatic function. Seasonal differences suggest that moisture, organic matter availability, and p^H strongly influence peroxidase accumulation in soils.

Review of Literature

Burns (1978) was among the first to emphasize that soil enzymes are integral components of nutrient cycling and can be used to assess soil quality and microbial activity. Later, Tabatabai (1994) described soil enzymes as reliable biochemical indicators of soil productivity and highlighted their importance in evaluating changes caused by agricultural practices.Peroxidases belong to the oxidoreductase group of enzymes and catalyse the oxidation of phenolic compounds using hydrogen peroxide as an electron acceptor. Passardi et al. (2004) reported that plant peroxidases are involved in lignification, cell wall formation, auxin metabolism, and plant defence against environmental stresses. These enzymes protect plant cells from oxidative damage by detoxifying reactive oxygen species.According to Gill and Tuteja (2010), peroxidases play an important role in the antioxidant defence system of plants by eliminating excess hydrogen peroxide generated under abiotic stresses such as drought, salinity, heavy metal toxicity, and extreme temperatures. Their study demonstrated that enhanced peroxidase activity is closely associated with improved stress tolerance in plants.In soils, peroxidases are mainly produced by plant roots, fungi, bacteria, and decomposing organic matter. Sinsabaugh (2010) explained that phenol oxidase and peroxidase enzymes regulate the decomposition of lignin and other complex organic compounds, thereby influencing carbon cycling and soil organic matter dynamics. Similarly, Nannipieri et al. (2012) reported that soil enzymes serve as sensitive indicators of microbial activity and are essential for nutrient transformation, organic matter decomposition, and maintenance of soil fertility.The influence of agricultural management on soil enzyme activity has been extensively investigated. Dick (1992) reported that long-term agricultural practices significantly affect soil biochemical and microbiological properties, including peroxidase activity. Conservation agriculture, crop residue incorporation, and organic amendments generally enhance soil enzyme activities by increasing microbial biomass and substrate availability.Environmental factors such as soil moisture, temperature, pH, and organic carbon strongly influence peroxidase activity. Deng and Tabatabai (1997) observed that tillage and residue management significantly affected soil enzyme activities due to changes in soil organic matter and microbial populations. Allison and Jastrow (2006) further demonstrated that extracellular enzyme activity increases in soils containing higher levels of organic matter and active microbial communities.

The role of peroxidases in environmental protection has also been recognized. Bansal and Kanwar (2013) reported that peroxidases participate in the degradation of phenols, pesticides, industrial dyes, and other toxic pollutants, making them valuable enzymes for environmental remediation. Likewise, Dube et al. (2010) highlighted the importance of soil enzymes in the biodegradation of industrial contaminants and the restoration of polluted soils.Fungal peroxidases also contribute significantly to organic matter decomposition. Baldrian (2006) described fungal oxidative enzymes as major contributors to lignin degradation in forest and agricultural soils. Datta et al. (2017**)** reviewed the enzymatic degradation of lignin and concluded that oxidative enzymes, including peroxidases, play an important role in maintaining soil carbon balance and ecosystem sustainability. Seasonal changes influence soil enzyme activities through their effects on soil moisture, temperature, and microbial biomass. Kumari and Rao (2018) reported that soil enzyme activities were generally higher during the rainy and winter seasons than during summer in agricultural ecosystems of Telangana. Increased soil moisture and organic carbon during these seasons promoted microbial growth and enzyme production.

Conclusion

The present investigation demonstrated significant seasonal variation in peroxidase enzyme activity among agricultural soils cultivated with paddy, groundnut, maize, and red gram. Higher enzyme activity was observed during the rainy and winter seasons, whereas lower activity occurred during summer due to reduced soil moisture, lower organic carbon content, and increased soil alkalinity. Among the different cropping systems, maize soils recorded the highest peroxidase activity, indicating enhanced microbial and oxidative activity under favorable soil conditions. The findings confirm that peroxidase activity is a reliable biochemical indicator of soil fertility, microbial activity, and ecosystem health. Monitoring soil enzyme activity can therefore assist in evaluating soil quality and developing sustainable agricultural management practices.

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