International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 1 August 2024, pp. 09-14

An Overview:Plant Extract as Biostimulant

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Abstract—The use of biostimulants in plants can enchace their physiological functions, promote growth, and mitigate the impact of stress factors on plants. Plant extract are one of the sources of biostimulants that have been extensively explored in crop recently. Plant extracts can enchace plant growth at all stage, including germination, harvest, and even post-harvest. A variety of beneficial compound in plant extracts, such a secondary metabolites, growth-promoting hormones, vitamins, and other bioactive compounds. Recent research indicates that several factors influence the effect of plant extract on plants, such as the type of plant used for the extract, the type of terget plant, concentration, and extraction method. Concern about the effectiveness of this biostimulants are required in order to find the best formula for incresing crop quality and yield.

Keywords—Biostimulan; Concentration; Extraction methods; Plant extract.

I. INTRODUCTION

Biostimulants are natural or synthetic organic compounds that are not fertilizers but can enhance plant growth and response to stress. Plant extract are a potential source of biostimulants that can improve nutrient efficiency and tolerance to both biotic and abiotic stress. Several plant extract developed in agriculture, such as microbial inoculants, humic acids, fulvic acids, amino acids, seaeed extracts, and plant extracts, have been proven tp enhance plant growth and crop quality [1]. Biostimulants can also stimulate and modify plant physiolological processes such as respiration, photosynthesis, nucleic acid synthesis, and ion uptake [2]. Additionally, biostimulants can enchance water retention capacity in plants, increase antioxidant levels, and boost chlorophyll production. Furthermore, biostimulants can stimulate plant growth, increase crop production, and maximize the uptake of nutrients suc as NPK and other micronutrients. They also play a role in improving fertilizer use efficiency by up to 50% [3]. Plant extracts containing bioactive compounds can enhance nutrient effeciency and increase tolerance to biotic and abiotic stresses [4]. Several types of bioactive compounds found in plant extracts, such a terpenoid, saponin, and flavonoid, play crucial roles as biostimulants that stimulate growth and improve crop yield [1].

Biostimulants exert their effect when penetrated into plant tissues. The type of biostimulant and the plant species treated ill yield different effect, influenced by the source of the biostimulant and the leaf permeability to which it is applied. The chemical structure and bioactive compounds of biostimulants significantly affect their penetration and absorption into leaves, especially through stomata. The effectiveness of biostimulants on plant is influenced by several factors such as dosage, application timing, weather conditions, external influencing factors, biostimulant composition, pupose of use, application method, and extraction method [4]. The type of solvent used in extraction is also a significant factor affecting the concentration of active substances produced [5]. This is due to the polarity of the solvent and the extracted material, which correlates with its solubility capacity [6].

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By undersanding these variables, strategies for utilizing biostimulants can be optimized to maximize benefits and efficiency in plant growth and production. Proper optimization of biostimulant application can facilitate achieving desired outcomes in agricultural practices.

II. RESULT AND DISCUSSION

The recent studies on the application of plant extract as biostimulants to enhance the growth and yield of crops. There are several factors affected the effect of plant extracts on crop including:

A. Types of Plant Extract and Crops

Studies about the effect of the types of plants extract on growth, concentration, and yield of plants are presented in (Table 1).

TABLE 1. EFFECT OF THE TYPES OF PLANTS EXTRACT ON GROWTH, CONCENTRASI, AND YIELD OF PLANTS

Plants Species	Plant	Concentration	Treatment Respon	Referensi
Resam fern extract (*Gleichenia linearis*)	*Glycine max*	Application of crude extract at a concentration of 100 mg/L	Increase plant height and leaf area and in soybean plants.	[7]
	Zea mays	Application of crude extract at a concentration of 100 mg/L	Increase height, leaf area, wet weight and dry weight of corn plant canopy	[8]
	Capsicum annum var. Kopay	Application of the extract at a concentration of 100 mg/L	Increase chili yields such as fruit wet weight and number of fruits per plant.	[9]
Vegetable fern extract (*Diplazium esculentum*)	*Capsicum frutescens*	Application of extract with 15% concentration	Effect on stomatal density and stomatal index	[10]
Ekstrak pegagan (*Centella asiatica*)	*Glycine max*	Application of the extract with a concentration of 25 mg/L	Enhances vegetative growth	[7]
	Zea mays	Application of the extract with a concentration of 25 mg/L	Increases plant height growth and leaf number	[8]
	Brassica oleracea	Application of the extract at a concentration of 50 mg/L	ncreases chlorophyll a, chlorophyll b, and total chlorophyll levels	[11]
Mangosteen peel extract (*Garciana mangostana*)	*Oryza sativa*	Application of the extract at a concentration of 50 mg/L	Increase root wet weight	[12]
Moringa leaf extract (*Moringa oleifera*)	*Vigna unguiculata*	Application of extracts with a concentration of 20-30%	Increase the growth of plant height, leaf width, leaf number, and chlorophyll number	[13]
	Solanum lycopersicum	Application of the extract by spraying onto tomato leaves two weeks after germination	Increases plant height, tomato production, and increases root dry mass	[14]
Moringa leaf and twig extract (*Moringa oleifera*)	*Eruca vesicaria*	Spraying 2% leaf extract and 3% twig extract	Increase plant height, wet weight, and dry weight	[15]

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Japanese tea seed extract (*Camellia sinensis*)	*Fragaria vesca*	Application of the extract at a concentration of 1.5 g/L	Triterpenoids and saponins contained in Japanese tea plant seed extract, can improve plant physiological responses and increase biomass.	[16]
Ekstrak kembang telang (*Asystasia gangetica*)	*Zea mays*	Application of the extract at a concentration of 75 mg/L	Affects growth in corn plants	[17]
Ekstrak bunga kenikir (*Cosmos sulphureus*)	*Zea mays*	Application of extract with 20% concentration	Shows the best results on corn seed germination	[18]
Grape peel extract (*Vitis vinifera*)	*Capsicum annum*	Application of the extract at a concentration of 50 ml/L at two sprays	Increase biomass and dry weight of chili plants	[19]
Ekstrak kembang telang (*Asystasia gangetica*)	*Glycihe max*	Pemberian konsentrasi 75 mg/l	Ekstrak *Asystasia gangetica* mengandung senyawa flavonoid, terpenoid, dan fenolik mempengaruhi berat kering akar	[20]

Compatibility between the biostimulant and the test plant is crucial in understanding how the biostimulant can affect plant growth and development. The process of plants receiving a response from the biostimulant involves the interaction between the biostimulant and plant cells. Biostimulants can bind to the cytoplasm or cell membrane, affect enzyme activity, or alter gene expression. In addition, biostimulants can also affect signaling pathways in cells, such as hormone signaling pathways, which affect plant growth and development.

The optimal concentration of biostimulants is essential to ensure the effectiveness and safety of biostimulant use. Concentrations that are too low may not provide the expected effects, while concentrations that are too high may cause toxic reactions or reduce plant growth. Optimal concentrations are usually determined through testing and research conducted before biostimulants are used on a commercial scale. To determine the optimal concentration, researchers usually use various methods, including in vitro and in vivo testing. In vitro methods involve testing biostimulants on customized plant media, while in vivo methods involve testing on live plants.

In some studies, biostimulants can interact with natural compounds in plants, such as plant hormones or secondary metabolites. These interactions can affect the effect of the biostimulant and may increase or decrease the response of the plant to the biostimulant. For example, a biostimulant designed to increase plant hormone production may have no effect if the plant already has high hormone levels. In research, the compatibility between the biostimulant and the test plant can be measured through various methods, such as measurements of growth, production, or the content of certain compounds in the plant. These methods help in determining the effectiveness and safety of using biostimulants on specific crops.

By understanding the factors that affect the compatibility between biostimulants and test plants, researchers can develop more effective and safe biostimulants for use in agriculture. This is crucial to ensure that the biostimulants used are not only effective in enhancing plant growth and productivity, but also safe for the plants and the environment.

B. Extraction Method

Studies about the extraction methods of plants extract on plant growth and yield of plants are presented in (Table 2).

TABLE 1. EFFECT OF THE METHODS OF PLANTS EXTRACT ON GROWTH, CONCENTRASI, AND YIELD OF PLANTS

Plants Species	Plant	Concentration	Treatment Respon	Referensi
Moringa leaf extract (*Moringa oleifera* L.)	*Capsicum frutescens*	Ethanol	Increase the number of leaves and plant height of cayenne pepper	[21]
	Amaranthus tricolor	Aquades, Methanol 70%, Ethanol 70%	Methanol and ethanol solvents are more effective for extraction in increasing the number of red spinach leaves	[22]
Centella asiatica extrat	*Glycine max*	Aquades	Increase in leaf area and dry weight of soybean plants grown in ultisol soil	[23]
	Brassica rapa L.	Methanol and Ethanol	Increases leaf number, leaf area, and chlorophyll content	[24]
	Glycine max	Methanol 70%	Increase height and leaf area of soybean plants	[7]

The extraction method of plant extracts to be used as biostimulants must be able to overcome the complexity of plant composition while maintaining the integrity of biologically active compounds that have biostimulant potential. One effective extraction method is using extraction with organic solvents, such as ethanol, acetone, and methanol. This method can produce extracts rich in bioactive compounds such as flavonoids, phenols, and alkaloids. These compounds have various functions that are important for plants, such as promoting growth, inhibiting pathogens, and increasing resistance to stress. By using extraction with organic solvents, these compounds can be extracted well while maintaining their structure and activity, so they can be applied as effective biostimulants. When applied to test plants, these compounds can enhance growth, reduce stress, and improve crop quality.

III. CONCLUSION

Biostimulants are substances that can enhance plant growth and development by interacting with plant cells. The compatibility between biostimulants and test plants is crucial for understanding their effects. Optimal concentrations of biostimulants are essential to ensure effectiveness and safety. Biostimulants can interact with natural compounds in plants, affecting their response. Researchers use various methods to determine optimal concentrations and compatibility, including in vitro and in vivo testing. Understanding these factors helps develop more effective and safe biostimulants for agriculture. Effective extraction methods, such as using organic solvents, are necessary to produce biostimulants with bioactive compounds that promote plant growth and health.

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