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Bio- herbicides: Safe Approach

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ARTICLE ID: 12

Abstract

Weeds are the leading source of crop yield loss. Synthetic chemical herbicides are very successful in weed control and provide significant weed reduction; but, when resistance develops, they become less effective in weed control. There is a need for a suitable alternative to chemical herbicides. Bio-herbicides are new weed control solutions on the market. Bioherbicides are a novel technique to weed management that is derived from live creatures or natural plant metabolites. Microbes- fungal, bacterial, and viral pathogens are included in bio-herbicides, while plant-based products include plant extract and essential oils. The bio-herbicide inhibits physiological activities such as nutrition intake and photosynthesis, as well as cellular functions such as cell wall and cell membrane, hormone and toxin production, and so on. For successful commercialization, various formulations have been developed to extend the shelf life of various bioherbicides.

Keywords: bio-herbicides, microbes, physiological activities, weed control

Introduction

Weeds are weeds that severely limit agricultural production. They compete with crops for water, gases, nutrients, space, light, and other growing factors, and they can also serve as hosts for pests and diseases Nichols *et al.* (2015). Weeds attack crop growth factors, causing yield losses of 15 to 66% in direct-seeded rice, 18 to 65% in maize, 50 to 76% in soybean, and 45 to 71% in groundnut Gharde Y *et al.* (2018). Weed-related crop production losses vary greatly depending on the crop, weed management practises, weed composition, infection time, and abiotic factors (e.g., climate and soil edaphic factors) Oerke (2006).Weed control is an important agronomic practise in agricultural farming. Because of labour shortages in agriculture, the use of pesticides to decrease weed densities is becoming more common around the world Aktar W*et al.* (2015).Herbicide resistance, residue in crops, ecological imbalance between dangerous and beneficial organisms, and environmental pollution have all

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been linked to the long-term use of herbicides on the same field to manage weeds. However, time constraints, developments in pest management technology, and a constant 'enticement' from the current agricultural system have pushed farmers to continue using traditional herbicides, which have been found to be effective, time- and cost-efficient, and environmentally friendly.

Weeds are unwanted plant populations that compete for resources with the primary plant and are a major cause of low agricultural output. Following World War II, the advent of selective herbicides, MCPA and 2,4-D, significantly decreased weed losses without affecting the main crop. Despite the fact that 25 herbicide sites have been discovered, weed resistance has been observed despite selectivity. Transgenic crops have been used over the world to battle resistance and replace previous chemical control approaches. Continuous development of advanced control technologies is essential to overcome weed management difficulties and maintain agricultural productivity.

Biological weed control is a mechanism that uses natural enemies, natural chemicals, or biotic agents to restrict the germination and growth of weed populations to an economically viable level. The administration procedures for bio herbicides and conventional herbicides are similar, though pathogenic fungus for myco herbicides is 'inoculated' by spraying the pathogens onto target weeds. Bio herbicides have recently been recognised as an important weed control component Hoagland *et al.* (2007), albeit not as a complete replacement, but rather as an alternative to chemical herbicides Singh *et al.* (2009). Unlike synthetic herbicides in conventional agriculture, sustainable weed management does not rely on a single weed management strategy; consequently, bio herbicides should be used in conjunction with other weed management techniques to control weeds.

Bio herbicides: A safe approach

Bio-herbicides are substances that suppress weed populations by the use of bio-organisms like as bacteria, diseases, or natural metabolites. It is made up of plant-based natural compounds, pathogens, and other microorganisms that are utilised in biological weed management. Bio-herbicides are a new technique for addressing the problems of conventional herbicides.

Bio herbicides are weed-controlling microorganisms such as pathogens and other microbes or phytotoxins generated from microbes, insects, or plant extracts. Bio herbicides, according to

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Bailey Bailey *et al.* (2014), are naturally derived products that can be used to manage weeds. However, while bio herbicides are composed of naturally occurring substances, this does not mean that they are fully safe. Plants contain natural toxins that can harm the health of non-flora species in the environment, as well as certain bacteria, viruses, and fungus that can harm animals and people Sekhar *et al.* (2012). As a result, natural poisons must be carefully handled to minimise unintended consequences for crops or beneficial fauna and flora. Duke S *et al.* (2000).

Classification of bio herbicides

Herbicides can be classified into two main categories:

a. **Pathogenic bio herbicides:** These are bio herbicides that suppress weeds by using harmful microorganisms such as fungi, bacteria, or viruses. These bacteria have been chosen precisely for their capacity to infect and kill weeds while being safe to crops. Pathogenic bio herbicides can be used in a number of methods, including spraying, drenching, and seed treatment. Pathogenic bio herbicides outperform conventional herbicides in several ways. They are frequently more environmentally friendly because they do not emit hazardous substances into the environment. They can also be more targeted, as they can be developed to eliminate certain weeds. Furthermore, pathogenic bio herbicides may be more successful than traditional herbicides because they can kill the weed plant rather than just slow its development. Pathogenic bio herbicides, however, have several drawbacks. They are more expensive than traditional herbicides and may not be effective in many settings. Furthermore, they may not be available for all weeds. Overall, pathogenic bio herbicides are a promising new weed control method. They have several advantages over traditional herbicides, and they are becoming more widely available. They are, nevertheless, a relatively new technology, and further research is required to fully comprehend their potential and limitations.

b. **Non-pathogenic bio herbicides:** These are a type of bio herbicide that uses non-pathogenic microorganisms, such as bacteria, fungi, or viruses, to control weeds. These microorganisms are specifically selected for their ability to interfere with the growth or development of weeds, without actually killing them. Non-pathogenic bio herbicides can be applied in a variety of ways, including spraying, drenching, or seed

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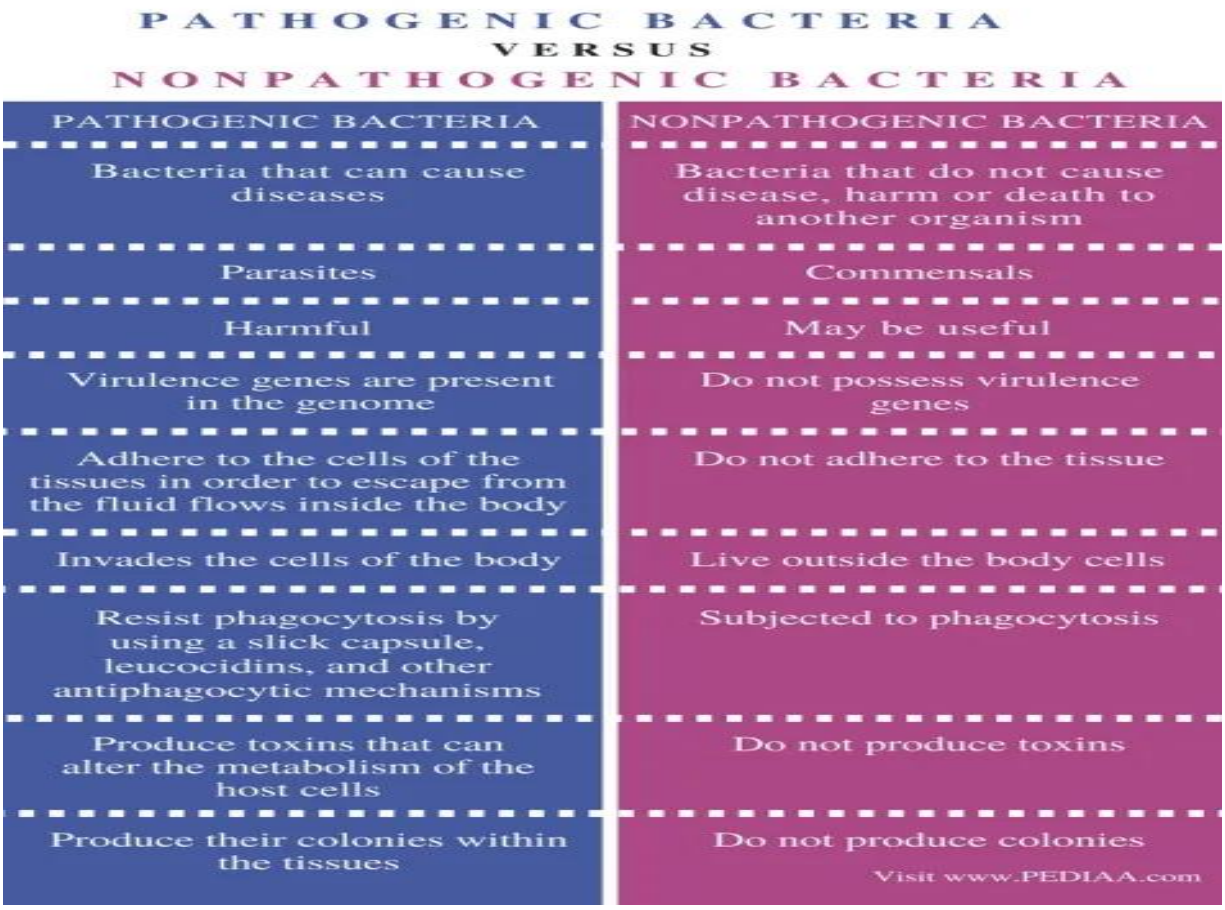
treatment. Non-pathogenic bio herbicides have a number of advantages over conventional herbicides. They are often more environmentally friendly, as they do not release harmful chemicals into the environment. They can also be more targeted, as they can be specifically designed to interfere with the growth or development of certain weeds. Additionally, non-pathogenic bio herbicides can be more effective than conventional herbicides, as they can cause the weed plant to become less competitive with crops. However, non-pathogenic bio herbicides also have some disadvantages. They can be more expensive than conventional herbicides, and they may not be effective in all situations. Additionally, they may not be available for all types of weeds. Overall, non-pathogenic bio herbicides are a promising new technology for weed control. They offer a number of advantages over conventional herbicides, and they are becoming increasingly available. However, they are still a relatively new technology, and more research is needed to fully understand their potential and limitations.



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Benefits of Organic Farming

Because of the increased public desire for safe 'green' goods, several new ecologically friendly pest and weed management products have become available. Bio herbicides derived from plant extracts, phytopathogenic microorganisms, or microbial phytotoxins (i.e., myco herbicides) are an effective weed control method Lamberth C *et al.* (2016); Cai X. (2016); Boyetchko S (2004). They typically lack a persistent property, which means that they do not remain active in the environment for lengthy periods of time, are less likely to cause soil and water contamination, and have no detrimental impacts on non-target organisms. Thus, bio herbicides derived from allele chemicals are neither hazardous to bio-ecosystems or human health Soltys D *et al.* (2013).Some allele chemicals are water soluble, making them easier to apply without the use of surfactants Dayan *et al.* (2009). Allelo chemicals have more environmentally benign chemical structures than synthetic herbicides. Allelo chemical bio herbicides typically have low toxicity and short environmental persistence, and they frequently employ numerous modes of action, which decreases the potential of herbicide resistance Bailey *et al.* (2014). As a result, allele chemicals are promising candidates for bioherbicides, antibacterial agents, and growth regulators.

Constraints

Despite all of the advantages of using bio herbicides to manage weeds in a more sustainable manner, there are some limitations that make bio herbicide application less appropriate than conventional synthetic herbicides, especially at the field scale. While a bio herbicide's environmental half-life is optimal for decreasing environmental toxicological, an effective herbicide must persist long enough to have the intended effect on weed species Manahan *et al.* (2017). Plants from the same region or taxonomic group do not produce the same amount or content of secondary metabolites, and hence do not exude the same amount or quality of allele chemicals Albert *et al.* (2012).

Effects of Plant-Based Bio herbicides on Weed Biochemistry

One of the most essential qualities of plant tissues is their ability to adapt to various environmental changes, allowing them to efficiently regulate and adjust to the altered habitat. Drought, heat, cold, salt, nutrient deficiency, and oxidative stress are examples of environmental variables that have a significant impact on plant production, resulting in morphological, physiological, and biochemical responses in plants Awasthi *et al.* (2014). One

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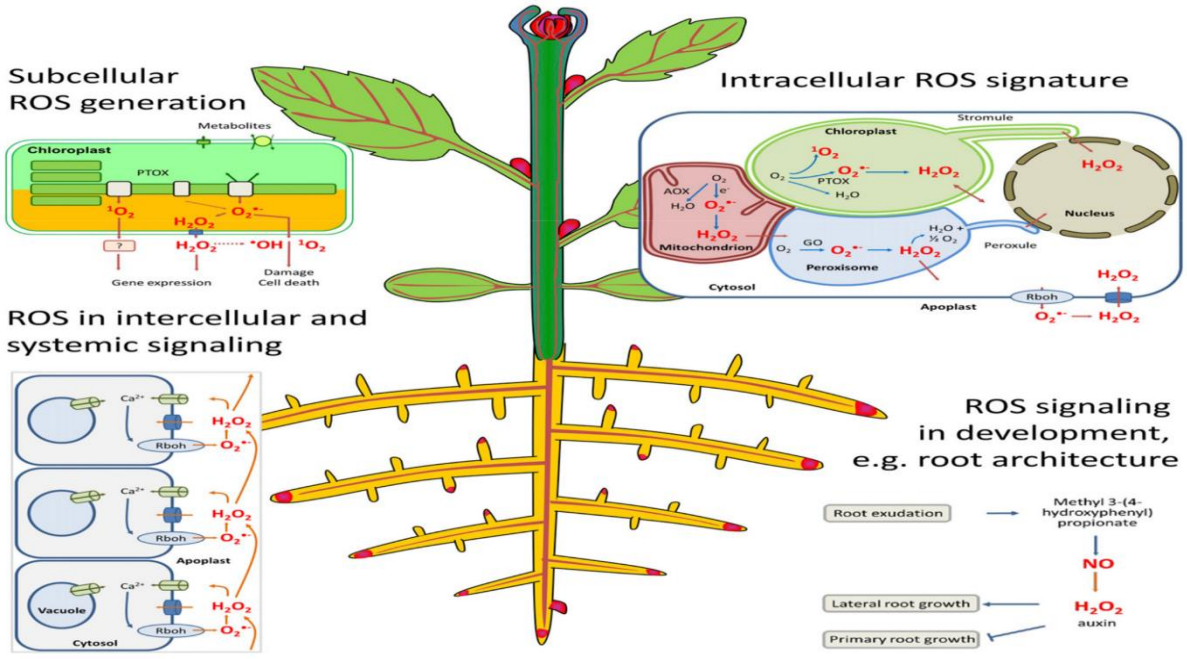
of the main effects of biotic and a biotic stresses that affect physiological and biochemical metabolism in plants is oxidative stress; thus, a balanced amount of reactive oxygen species (ROS) scavenging through proteins and antioxidant enzymes is required Grene *et al.* (2002).Many studies have found that ROS are the primary source of cell damage in both biotic and a biotic stress Gara *et al.* (2003). These oxidative molecules are typically formed when oxygen is reduced by one, two, or three electron transfers to form hydrogen peroxide, superoxide, and hydroxyl radicles, which are highly reactive species that are cytotoxic to bio molecules like nucleic acids, proteins, and lipids, causing protein denaturation and lipid per oxidation Quiles *et al.* (2004).



Because ROS can react with unsaturated fatty acids to generate peroxidation of the lipid bilayer in both cellular and intercellular structures, the plasma membrane is the major site of cellular and organelle injury. Cellular damage causes leaking of cellular contents, rapid desiccation, and, eventually, cell death Janda *et al.* (2012), whereas intercellular damage inhibits mitochondrial respiratory function and induces pigment breakdown in chloroplasts Huang *et al.* (2016).Normal cell metabolism generates ROS in organelles such as chloroplasts (photosynthesis), mitochondria (photorespiration), and peroxisomes (respiration), all of which are potent ROS makers. In general, ROS act as an oxidant of proteins and lipids, altering their functionalities by releasing single active chemicals that govern photosynthesis, floral senescence, pollen generation, root formation, and root hairs

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Dietz *et al.* (2016).Catalase (CAT), monodehydroascorbate reductase (MDA), peroxidase (POD), superoxide dismutase (SOD), guaiacol peroxidase (GPX), and glutathione reductase (GSH) activity is thus a useful biomarker of plant stress.

Conclusion

Weed pests are a major element in crop output decline and have become a serious impediment to meeting the food needs of the world's growing population. Despite the fact that bio-herbicides are safe and sustainable, they are not used in agricultural practises. More research and development is needed to improve the activity of bio-herbicides and commercialise them. Because bio-herbicides do not cover a wide range of weed species in the field, host specificity is a key issue. Bio herbicides should be utilised as part of an integrated strategy to avoid key issues such as resistance and host specificity. Bio-herbicides may be the primary weed control agent for organic farming promotion. As a result, several new generation formulation strategies can improve the efficiency of the bioherbicide.To address a wide range of weed species, a formulation should be devised using a combination of diverse bio control agents.

Refrences

Aktar W., Sengupta D., Chowdhury A. Impact of pesticides use in agriculture: Their benefits and hazards. *Interdiscip. Toxicol.* 2009;2:1–12.

Albert A. *Selective Toxicity: The Physico-Chemical Basis of Therapy*. Springer Science & Business Media; Berlin/Heidelberg, Germany: 2012.

Awasthi R., Kaushal N., Vadez V., Turner N.C., Berger J., Siddique K.H., Nayyar H. Individual and combined effects of transient drought and heat stress on carbon assimilation and seed filling in chickpea. *Funct. Plant Biol.* 2014;41:1148–1167. doi: 10.1071/FP13340.

Bailey K.L. *Integrated Pest Management.* Academic Press; Cambridge, MA, USA: 2014. The bioherbicide approach to weed control using plant pathogens; pp. 245–266.

Boyetchko S., Peng G. Challenges and strategies for development of mycoherbicides. *Fungal Biotechnol. Agric. Food Environ. Appl.* 2004;21:111–121.

Cai X., Gu M. Bioherbicides in organic horticulture. *Horticulturae*. 2016;2:3. doi: 10.3390/horticulturae2020003.

Dayan F.E., Cantrell C.L., Duke S.O. Natural products in crop protection. *Bioorg. Med. Chem.* 2009;17:4022–4034. doi: 10.1016/j.bmc.2009.01.046Gharde Y., Singh P.K., Dubey R.P., Gupta P.K. Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Prot.* 2018;107:12–18. doi: 10.1016/j.cropro.2018.01.007.

Dietz K.J., Mittler R., Noctor G. Recent progress in understanding the role of reactive oxygen species in plant cell signaling. *Plant Physiol.* 2016;171:1535–1539.

Gara L.D., de Pinto M.C., Tommasi F. The antioxidant systems vis-à-vis reactive oxygen species during plant—Pathogen interaction. *Plant Physiol. Biochem.* 2003;41:863–870. doi: 10.1016/S0981-9428(03)00135-9.

Grene R. Oxidative stress and acclimation mechanisms in plants. *Arab. Book Am. Soc. Plant Biol.* 2002;1:e0036. doi: 10.1199/tab.0036.1.

Hoagland R.E., Boyette C.D., Weaver M.A., Abbas H.K. Bioherbicides: Research and risks. *Toxin Rev.* 2007;26:313–342. doi: 10.1080/15569540701603991.

Huang S., Van Aken O., Schwarzländer M., Belt K., Millar A.H. The roles of mitochondrial reactive oxygen species in cellular signaling and stress response in plants. *Plant Physiol.* 2016;171:1551–1559. doi: 10.1104/pp.16.00166.

Janda K., Hidega E., Szalai G., Kovacs L., Janda T. Salicylic acid may in-directly influences the photosynthetic electron transport. *J. Plant Physiol.* 2012;169:971–978. doi: 10.1016/j.jplph.2012.02.020.

Lamberth C. Naturally occurring amino acid derivatives with herbicidal, fungicidal or insecticidal activity. *Amino Acids.* 2016;48:929–940. doi: 10.1007/s00726-016-2176-5.

Manahan S.E. *Environmental Chemistry*. CRC Press; Boca Raton, FL, USA: 2017.

Nichols V., Verhulst N., Cox R., Govaerts B. Weed dynamics and conservation agriculture principles: A review. *Field Crops Res.* 2015;183:56–68. doi: 10.1016/j.fcr.2015.07.012

Oerke E.C. Crop losses to pests. *J. Agric. Sci.* 2006;144:31–43. doi: 10.1017/S0021859605005708

Quiles M.J., López N.I. Photoinhibition of photosystems I and II induced by exposure to high light intensity during oat plant growth: Effects on the chloroplast nadh dehydrogenase complex. *Plant Sci.* 2004;166:815–823. doi: 10.1016/j.plantsci.2003.11.025.

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Sekhar J.C., Sandhya S., Vinod K.R., Banji D., Sudhakar K., Chaitanya R.S.N.A.K.K. Plant toxins-useful and harmful effects. *Hygeia. J. D. Med.* 2012;4:79–90.

Singh S., Chhokar R.S., Gopal R., Ladha J.K., Gupta R.K., Kumar V., Singh M. *Integrated Crop and Resource Management in the Rice—Wheat System of South Asia.* International Rice Research Institute; Los Banos, The Philippines: 2009. Integrated Weed Management: A key to Success for Direct-seeded Rice in the Indo-Gangetic Plains; pp. 261–278.