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AL04517

IMPACT OF NOISE POLLUTION ON THE SOUNDSCAPES OF RIVERS AND LAKES AND ITS EFFECTS ON AQUATIC LIFE

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Freshwater habitats are full of sounds fish, frogs, insects, and even river mammals depend on noise to talk, find mates, and make their way around. But when people bring in boats, build things near water, dump storm water runoff, or run hydroelectric plants, all that extra noise piles up fast. It scrambles the underwater "conversations," stresses out wildlife, messes with reproduction, and can even cause young animals to develop abnormally. Even though this is a big deal for river and lake life, most environmental policies still ignore freshwater noise pollution. But thanks to new technology like passive acoustic recorders and AI that can sift through hours of recorded river sounds we finally have the tools to understand how noisy it really is and how it's affecting wildlife, almost in real time. That means it's time for lawmakers to recognize that sound matters just as much as chemical pollution when it comes to water quality. Adding acoustic standards to water protection laws and pushing for quiet seasons or switching to electric boats will help protect freshwater creatures and keep these ecosystems alive, even as the world gets louder.

Fish use drumming, clicking, and grunting to entice mates. In shallow margins, frogs call. Through gravel beds, invertebrates rustle. The acoustic richness of this underwater world is not coincidental; rather, it is necessary. However, that symphony is being muffled today in all of the world's wetlands, rivers, and lakes. Freshwater ecosystems are being inundated with artificial noise from hydropower turbines, construction blasting, urban drainage, and boat engines; the effects on aquatic life are still not fully understood. This acoustic identity has been present in freshwater ecosystems for millions of years. Aquatic life developed in a world ruled by sound long before humans constructed cities, dammed rivers, or launched motorboats. In order to make mating calls, fish evolved specialised muscles. At dawn, amphibians adjusted their vocal cords to frequencies that travelled through still water. Using acoustic landmarks, such as the distinct rumble of a waterfall or the faint vibration of a gravel bed, migratory species

were able to navigate upstream. In these systems, sound wasn't just background noise. It was the unseen framework of existence. However, the infrastructure is deteriorating now. The ancient soundscape is being methodically overtaken throughout the world's wetlands, rivers, and lakes. Breeding grounds are filled with the roar of motorboat engines. River beds are rocked by construction blasting. All year long, urban drainage systems dump noisy, churning water into streams. Hydropower turbines never stop humming. Aquatic life has not evolved to cope with the wall of mechanical noise that is gradually replacing what was once a rich biological chorus.

Natural Soundscape Beneath the Water

Millions of years of evolution have shaped the unique acoustic characteristics of freshwater ecosystems. Each river or lake has a distinct "voice," made up of biological sounds (biophony), natural environmental sounds like wind and rain (geophony), and increasingly man-made sounds (anthrophony), according to scientists who study this field, known as soundscape ecology. The biological layer predominates in a healthy system. Fish species with specialised muscles attached to their swim bladders, such as gobies, cichlids, and catfish, produce surprisingly complex sounds. These sounds have meaning; they are not arbitrary. During spawning, male fish use calls to entice females. Sound is used by dominant people to protect their territory. After hatching, larvae use auditory cues to find appropriate habitats. In a nutshell, freshwater species have relied on the acoustic environment as a communication network for survival throughout geological time.

Freshwater soundscapes are amazing because of how well they adapt to their surroundings. Based on their physical features, rivers, lakes, wetlands, and estuaries each produce unique acoustic conditions. Water depth, flow velocity, substrate composition, and surrounding vegetation all influence how sound travels and is perceived. Compared to species that live in slow, deep lowland rivers, those that live in swiftly moving mountain streams have evolved calls at different frequencies. Because of the accuracy of this acoustic adaptation, scientists can frequently determine the type of habitat by examining its soundscape without ever having to see the organisms up close. In a very real sense, the soundscape is an ecosystem's fingerprint. Freshwater soundscapes aren't just about fish the whole ecosystem gets involved. Frogs and toads really steal the show during breeding season, when the guys line up by the water and fill the air with those wild, nonstop choruses. Then you've got aquatic insects like water bugs and some beetles, making underwater noises by rubbing their bodies together in

ways totally unique to their species. Shrimp and crayfish add their own sounds, mostly when they're moving around or feeding. And honestly, even a bunch of small fish zipping through the water creates hydrodynamic noises that others pick up and react to. From tiny invertebrates on the riverbed to big predators cruising the open water, every creature, big or small, shapes and relies on this collective underwater soundtrack.

Human Noise

Sound moves way faster in water is about four times faster than it does in air. So, underwater noise doesn't just stick around; it spreads out quickly and covers a lot of ground. Take a motorboat cruising across a lake. Its engine sends a racket that doesn't just bother the surface it dives deep, echoing throughout the water and reaching all kinds of aquatic life nearby. Construction near rivers, like pile driving or dredging, makes huge, low-frequency thumps that can travel for kilometres. Cities push storm water noisily through drains right into rivers, adding a constant jumble of sounds. Hydropower turbines hum away day and night and never really stop. Then there's commercial shipping in big rivers like the Amazon, Ganges, or Mississippi. It's always there, creating a steady background noise that simply didn't exist a couple hundred years ago. Chemical pollutants usually get weaker the further they travel. But sound travels through water without losing much force, so just one noise like a motorboat can send ripples of racket through a huge chunk of lake. It's not just the water right next to the boat that gets loud. That engine buzz fans out everywhere, and animals hundreds of meters away can hear it clear as day.

Hardships of Aquatic Life

Freshwater noise pollution messes with wildlife in ways you can't ignore. The clearest example is acoustic masking. Basically, human noises such as boat engines or construction spill right into the sound frequencies animals use to talk with each other, drowning out their messages. For fish trying to breed, this gets ugly pretty fast. If a male's mating call just blends into the background noise, females can't find him, and fewer pairs end up spawning. There's solid research on plain fin midshipman fish and different kinds of freshwater gobies: the males surrounded by noise have way less luck reproducing. Frogs aren't immune, either. The ones stuck near highways or city streams end up calling louder and at higher pitches, desperately trying to cut through the noise. It's exhausting and, honestly, it makes them less attractive to potential mates. Over time, this kind of chronic strain wears them out.

Neglected Crisis

Freshwater noise pollution barely gets noticed compared to all the headlines about ocean noise. Stories about whales losing their way because of ship engines or military sonar spark big international campaigns and even lead to new laws. But rivers and lakes places teeming with life barely get a mention when it comes to noise rules. Most countries haven't set any legal limit on how loud things can get in these waters. Even when people plan to build something next to a river, the environmental review usually skips the noise question entirely. Part of the problem is that scientists are still figuring out how sound affects freshwater animals. But there's another reason and that is the businesses that make most of the noise shipping companies, dam operators, city developers have money and political clout, so their interests tend to drown out the issue.

Required Changes

Honestly, we know how to tackle freshwater noise pollution it's more about having the guts to act. Setting up seasonal quiet zones around key breeding and spawning spots, so motorized boats stay out during peak times, is a simple fix that can make a real difference. Some lakes in Europe are already trying out electric-only boat areas, and the early results look promising. When construction happens near sensitive waters, crews should run acoustic impact checks and use noise barriers or plan work schedules to avoid disturbing wildlife during crucial periods. On a bigger scale, noise needs to be treated just like pH, dissolved oxygen, and chemical contamination in water laws. If we make sound a measurable and enforceable part of environmental policy, we're not just talking we're actually protecting these habitats.

The biggest change we need is a shift in how we think about and value the sounds of our freshwater ecosystems. For years, we've measured water quality almost entirely by chemistry and biology things like how much dissolved oxygen is in the water, how clear it looks, and whether it has any harmful pollutants. That definition has worked well enough to support laws and efforts that have cleaned up our rivers and lakes. But it's only part of the story. If we start to see acoustic health the actual soundscape of these places as just as important, we're opening up a whole new way of caring for our waterways.

This change means more than just adding a line to a checklist. We'd need to teach water managers, engineers, and urban planners why freshwater sound matters to the creatures that live there. Acoustic literacy would have to become part of their training. We need to fund

projects that actually listen to rivers over years, so we catch problems early and can see what's getting better when we take action. And we have to get people thinking about the sounds of rivers their value, their beauty, and the fact that they're fading away. Laws and policies follow public concern, and we won't get far unless people realize that a river's voice is something real and worth saving. We've gotten good at valuing clean water. Now, it's time to value quiet water. Not silent, empty water, but the kind that's alive with the hum, clicks, and flow of a healthy river a river telling its own story again.

Conclusion

For a long time, people have judged the health of rivers and lakes by what they can see or measure how clear the water is, what kinds of plants and animals live there, and what pollutants show up in tests. But honestly, there's more to the story. It's time to listen, too. When a river goes quiet, that's not a good sign. Silence means something's missing. The sounds you hear in healthy freshwater places birds, insects, water moving aren't just nice to have. They're signs of life. If we start paying attention to these sounds, we might finally give our rivers the care they need.

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GERMINATING UNDER-DEVELOPED SEEDS OF KINNOW MANDARIN AND MOSAMBI ORANGE FOR IDENTIFICATION OF TRIPLOID SEEDLINGS

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Triploid breeding in citrus is widely employed for the development of seedless cultivars; however, recovery of triploid progeny is often constrained by poor seed development and low germination rates, particularly in tetraploid x diploid crosses. The development of seedless cultivars is a major breeding objective driven by consumer preference and market demand (Kiran *et al.*, 2024a, b). Triploid breeding has emerged as an effective approach to achieve seedlessness in citrus (Aleza *et al.*, 2010). Triploids are generally obtained through crosses between tetraploid and diploid parents. However, such crosses often result in under-developed or abortive seeds due to endosperm imbalance and embryo abortion (Esen and Soost, 1973). These seeds typically fail to germinate under natural conditions, limiting the recovery of triploid progeny. Conventional embryo rescue techniques using *in vitro* culture are effective but expensive and technically demanding. The citrus triploids are generally developed by crossing tetraploids with diploids, but the resultant seeds do not germinate under normal conditions because of poor seed development and to germinate them, *in vitro* tissue culture seedling raising protocols are followed, which are very tedious and costly too.

A protocol for germination of less-developed seeds under normal conditions in the laboratory was tried by sowing them in petri-plates (Fig. 1). The sowing of poorly developed and bold seeds of tetraploids of Kinnow and Mosambi was done for the identification of triploids with the help of chromosome counting in the root tips and by flow cytometry. The seeds were washed properly and put in moist tissue paper. Both the seed coats were removed without disturbing the embryos and cotyledons. The seeds without seed coat were put on moist tissue paper laid in the petri plates. The tissue papers were kept moist continuously by adding a few drops of water in the petri dishes as and when required. After about 10 days, gemmation commenced and the resultant seedlings were transplanted in the seed trays filled with commercial soil mixture (soil: sand: FYM in 1:1:1 ratio) after one month of seed sowing (Fig.

2 and 3). The seedlings were maintained in seed trays under laboratory conditions for about four months and then shifted to the field in the raised beds. In total, 11 seedlings from poorly developed seeds of Kinnow mandarin and 91 seedlings from Mosambi were transplanted in the field for detailed evaluation and for confirmation of triploidy using morphological, physiological, cytological and flow cytometrical techniques (Fig. 4). On transplanting to field, all the seedlings survived and no mortality was recorded as generally observed in hardening process in *in vitro* raised plants (Table 1).

This technique of germinating under-developed seeds under *in vivo* conditions can prove useful as it does not require any *in vitro* conditions, which are comparatively very costly in nature. The technique is also user-friendly and can also be tried for fast germination of the normal seeds in the nursery and can save lot of resources. Further, the protocol eliminates the need for *in vitro* embryo rescue and provides a practical alternative for citrus breeding programs.

Table. 1. Seeds sown, germinated and successful transfer of seedlings in nursery beds

Genotype	Seed sown		Seeds germinated		Germination (%)		Transplanting of seedlings in raised beds	
	Under-developed	Bold	Aborted	Bold	Aborted	Bold	Transplanted	Survived
2021								
Mosambi	120	165	25	94	20.83	56.97	14	14
Kinnow mandarin	75	105	5	32	6.67	30.48	12	12
2022								
Mosambi	320	720	77	504	18	70	77	77
Kinnow mandarin	495	860	89	594	24	69	11	11



Fig. 1. Under-developed and bold seeds **Fig. 2.** Germination in bold & under-developed seeds



Fig. 3. Transferring germinated seeds in the plastic trays carrying commercial soil mixture



Fig. 4. Seedlings from under-developed seeds established in the field beds.

Conclusion

A simple, efficient, and low-cost *in vivo* germination protocol was standardized for under-developed seeds of Kinnow mandarin and Mosambi orange. The method successfully enabled recovery of viable seedlings suitable for triploid identification without the need for *in vitro* embryo rescue. This approach can significantly benefit citrus breeding programs, especially in resource-limited settings, and may be applicable to other crops exhibiting seed abortion problems.

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IMPACT OF TINY MICROBES: A SUSTAINABLE WAY TO BOOST SOIL AND CROP PRODUCTIVITY

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Soil beneficial microorganisms have potential activity towards soil health and plant growth. Several research addressed that these microbes have roles in supporting plant growth with soil nutrient improvement. Single strains like *Pseudomonas* for phosphate solubilization, *Rhizobium* for nitrogen fixation gained importance as potential biofertilizer. By reducing chemical fertilizer application, microbial consortium enhances crop productivity in an economically feasible way. These findings support the big impact of tiny microbes towards sustainable agriculture to support global food security.

Limitation of Conventional Farming

Recently agriculture is under increasing pressure to improve crop productivity while maintaining soil health. modern agricultural practices such as using large number of chemical fertilizers, excessive tillage and more along with improving yield, harms the soil quality. For long term these practices becoming harmful and that becomes the threat to food security. Food and Agricultural Organization (FAO), published a report that by 2030, about 600 million people worldwide are expected to be undernourished (FAO 2023). Along with soil health, application of chemical fertilizer leads to concerning environmental pollutions too (Wang and Li, 2019). Sustainable solution became emerging to solve this soil related and agricultural problems.

Impactful Tiny Microbes

One promising approach to combat the situation is the application of impactful soil beneficial microorganisms as biofertilizer. Soil is a dynamic ecosystem where microbes play important functions like nutrient cycling, decomposition, and plant growth promotion. There are several groups of microorganisms, including bacteria, fungi, archaea, actinomycetes, capable of fixing nitrogen, solubilizing phosphate, potassium, sulfur and other macro and

micronutrients- essential for crop development (Pradhan et al. 2025). Application of these microbes as a consortium has the ability to reduce the dependency of chemical fertilizers to improve the crop productivity in a sustainable way (Shimada et al. 2024).

N, P, and K Fixation/Solubilization/Mobilization

Nitrogen, one of the major nutrients for soil structure and crop productivity, required for synthesis of proteins, nucleic acids, and chlorophyll. Nitrogen is abundant in atmosphere, however gaseous nitrogen is unavailable to plants before it converted to available form like ammonia, nitrite or nitrate form by some nitrogen fixing bacteria. And in this way nitrogen fixer helps the soil to be nitrogen rich and support the plant growth. Symbiotic and free-living nitrogen fixers like *Rhizobium*, *Azospirillum* helps to fix nitrogen for legumes and cereals respectively (Aasfar et al. 2024). There are several other strains like *Pseudomonas*, *Azotobacter* and others helps as nitrogen fixers (Biswas et al. 2024). Along with nitrogen phosphorous and potassium, were solubilizing/ mobilizing by some phosphate solubilizing and potassium mobilizing bacteria from their insoluble form to soluble form. Several bacteria like *Enterobacter*, *Bacillus*, *Pseudomonas* has the potential to solubilize and mobilize these soil nutrients to support the plant growth while maintaining soil quality (Pandey and Saharan, 2025). Microbial consortium made up with these microbes is an impactful approach for the modern agriculture to be sustainable for soil health regeneration and crop production.

Micronutrients Solubilization

Not only macronutrients, micronutrients like zinc (Zn), and manganese (Mn), iron (Fe), and sulfur (S), also has several roles in maintain soil health and plant growth. There are several microbes those helps in solubilizing these micronutrients to soil for the plants. Bacteria such has *Bacillus subtilis* has potential activity to plant growth by helping mobilizing zinc like micronutrients. *Pseudomonas*, *Enterobacter*, *Thiobacillus* like species has roles in solubilizing iron, zinc, sulfur like micronutrients through their enzymatic activities (Yadav et al. 2023a). Including these micronutrient solubilizing bacteria in a microbial consortium can be a sustainable solution towards agriculture.

Microbial Consortium and Economic Feasibility

Traditional agriculture relies heavily on costly chemical fertilizers, which are environmentally unsustainable, and sometimes inefficient in nutrient-depleted soils. In contrast, microbial consortia can enhance nutrient availability in situ while minimizing

environmental impacts. Beyond agronomic benefits, microbial inoculants also have significant economic potential (Yadav et al. 2023b). The profitability of farming systems depends not only on yield but also on input costs and the efficiency of resource utilization. Application of microbes instead of chemical fertilizer cut the cost for purchase and application and improved productivity that increase the profit. In this way these tiny microbes help in global economic along with soil health and plant productivity.

Future Perspective

Preparation of a microbial consortium with potential microbes with an improved shelf life will be beneficial for the agricultural sector. Complete study from preparation to application in field scale with different field conditions and crop will help to understand the consequences of the microbial formula. This can serve as a potential sustainable method to improve and maintain the soil quality to support the plant growth and economic stability.

Conclusion

Tiny microorganisms have the potential to improve both the soil quality and structure, that helps the soil to function properly. Soil functionality of supporting plant growth, protecting it from several harmful diseases were lies on its structure, fertility, especially on biological load. So along with decreasing dependency over chemical fertilizer and pesticides microbial consortium helps to improve productive yield to combat the situation of food security. In other way bioaugmentation helps to reduce the cost of farming and hence helping in economic growth as well. Not only productivity it helps to improve the quality of crop as well. Therefore, it serves as a sustainable way to reduce cost of farming, improving soil health, productivity and quality of crops. Future studies focusing on all these aspects together will help researchers to find out the better sustainable and market available microbial consortium.

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MICROGREENS: TINY PLANTS, THE FUTURE OF FUNCTIONAL SUPERFOODS

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In the world of healthy eating, big benefits sometimes come in tiny packages. Microgreens young, tender shoots harvested just after the first leaves appear are quickly gaining popularity among chefs, nutritionists and home gardeners alike. Despite their small size, these miniature greens are power-packed with vitamins, minerals and antioxidants, contains higher nutrient levels than their fully grown counterparts. Easy to grow at home, versatile in kitchen and bursting with flavor and they are not just a garnish they are a superfood you can eat every day.

What are Microgreens

Microgreens, known as “vegetable confetti” and they are immature, nutrient-rich leafy vegetables harvested at the early seedling stage typically 7 to 21 days after germination, when the cotyledons are fully developed and one or two true leaves may begin to appear, usually 2–8 cm in height (Treadwell *et al.*, 2013). Unlike mature vegetables, microgreens are harvested without their roots, giving them a compact, delicate structure. Despite their small size, they offer concentrated flavors, brilliant colors and a tender texture that can elevate everything from everyday meals to gourmet dishes (Mitra *et al.*, 2025). They are rich in phytonutrients, including antioxidants, vitamins, minerals and phenolic compounds, which make them a next-generation superfood or functional food (Samuoliene *et al.*, 2019)

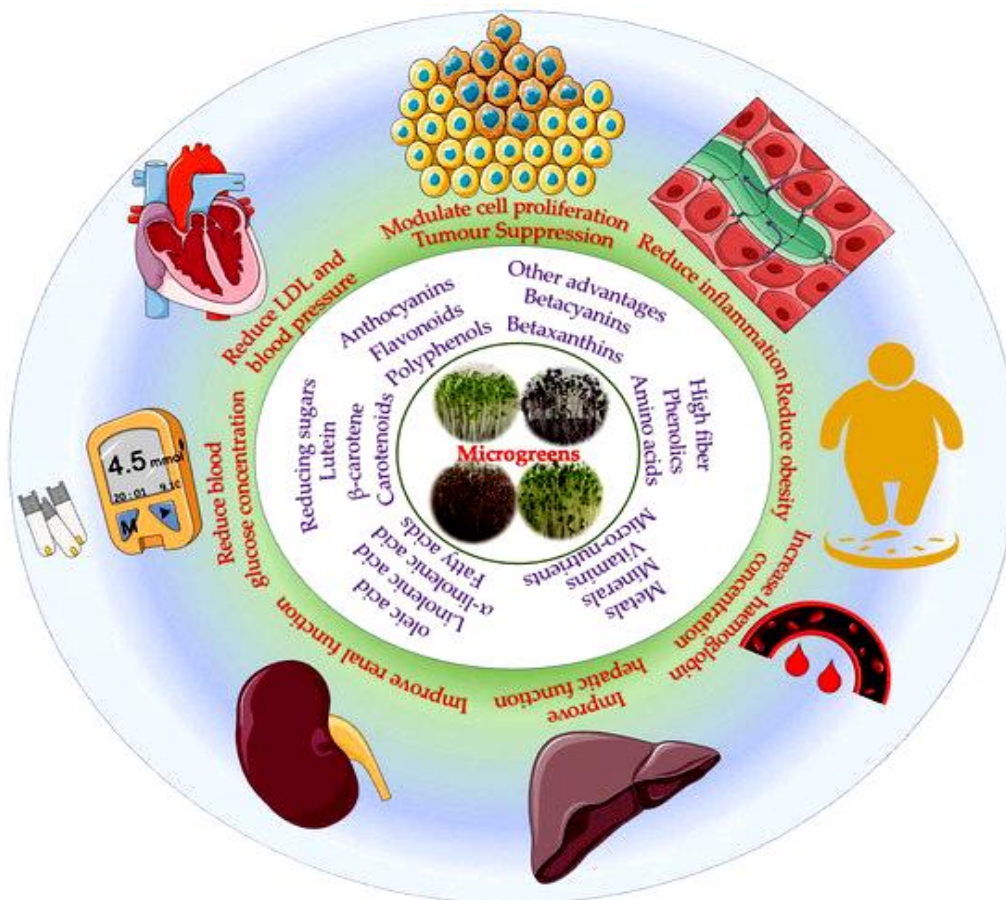
Nutrient Power of Microgreens

Commonly grown microgreens include varieties of mustard, radish, lettuce, cabbage, buckwheat, spinach, basil and other leafy greens. These types not only differ in taste ranging from sweet and mild to peppery or slightly spicy but also in their nutrient profiles (Mitra *et al.*, 2025). What makes microgreens especially exciting is their nutrient density: several studies report that microgreens can contain 4–40 times higher concentrations of nutrients (such as

vitamins, minerals and antioxidants) compared to their mature counterparts (Priyadarshini *et al.*, 2025). For instance, microgreens from brassica species (like red cabbage) can be exceptionally rich in vitamin E and vitamin C and some microgreens even show elevated levels of carotenoids and phenolic antioxidants (Vucetic *et al.*, 2025).

Health Benefits of Microgreens

Microgreens are considered functional foods due to their rich content of phytonutrients, vitamins, minerals and antioxidants, offering multiple health benefits (Bhaswant *et al.*, 2023).



In essence, microgreens serve as a compact, nutrient-dense solution for improving overall health, preventing chronic diseases and supporting balanced nutrition. Given their nutritional richness and compact growing habit, microgreens have found growing popularity not just in high-end kitchens and chef's dishes, but also in home gardening. They are used as garnishes or functional food components in salads, soups, sandwiches, smoothies and more. Their fast growth cycle, small footprint and year-round cultivation potential make them especially well-suited to urban agriculture and sustainable food systems.

What Are All the Crops Can Be Grown as Microgreens

Sprouts and microgreens are grown from the seeds of many crops, such as legumes, cereals, pseudo-cereals, oilseeds, vegetables and herbs (Source: Ebert, A. W, 2022)

Plant Family	Microgreen Crops	Uses / Benefits
Amaranthaceae	Amaranth, Beet, Quinoa, Spinach, Buckwheat, Chard	Rich in vitamins (A, C, K), minerals (Fe, Ca, Mg), antioxidants; supports heart health and immunity
Amaryllidaceae	Garlic, Onion, Leek	Antimicrobial, antioxidant, cardiovascular benefits; enhances flavor
Apiaceae	Parsley, Carrot, Fennel, Celery, Dill, Chervil, Cilantro, Coriander	Rich in vitamins, antioxidants, digestive aids; improves flavor and aroma
Asteraceae	Lettuce, Radicchio, Chicory, Endive, Tarragon, Common Dandelion	High in dietary fiber, vitamin K, antioxidants; supports digestive and metabolic health
Boraginaceae	Phacelia	Contains bioactive compounds; attracts pollinators; used as a cover/companion crop
Brassicaceae	Radish, Watercress, Arugula, Broccoli, Cauliflower, Cabbage, Chicory, Wild Rocket	Rich in glucosinolates, vitamins C & K, antioxidants; anti-cancer, anti-inflammatory, immune boosting
Convolvulaceae	Water Convolvulus	High in fiber and antioxidants; detoxifying properties
Cucurbitaceae	Melon, Cucumber, Squash	Hydrating, rich in vitamins, minerals; antioxidant and skin health benefits
Malvaceae	Jute Mallow / Nalta Jute	High in iron and calcium; supports bone and blood health
Poaceae	Corn, Lemongrass	Energy-rich, antioxidant and antimicrobial; lemongrass adds flavor and aroma
Lamiaceae	Chia	Rich in omega-3 fatty acids, antioxidants and fiber; supports heart and brain health
Leguminosae / Fabaceae	Chickpea, Alfalfa, Bean, Green Bean, Fenugreek, Fava Bean, Lentil, Pea, Clover	High in protein, minerals, antioxidants; supports muscle health, immunity and digestion
Onagraceae	Evening Primrose	Source of essential fatty acids; supports hormonal balance and skin health
Portulacaceae	Common Purslane, Moss-Ross Purslane	Rich in omega-3 fatty acids, antioxidants and vitamins; anti-inflammatory and heart health
Cereals	Oat, Soft Wheat, Durum Wheat, Corn, Barley, Rice	Rich in carbohydrates, protein, fiber; supports energy metabolism and gut health
Oleaginous Plants	Sunflower	Rich in vitamin E, healthy fats; antioxidant and heart health benefits

Fiber Plants	Flax	High in omega-3 fatty acids and lignans; supports cardiovascular and digestive health
Aromatic Herbs	Basil, Chives, Cilantro, Cumin	Rich in antioxidants and flavor compounds; digestive, anti-inflammatory and antimicrobial benefits

Conclusion

Microgreens represent a promising, nutrient-dense food source that combines health, sustainability and ease of production. Their rich composition of vitamins, minerals and antioxidants makes them valuable in combating malnutrition and lifestyle diseases. With rapid growth and minimal space requirements, they are ideal for urban and home cultivation. Incorporating microgreens into daily diets can significantly enhance nutritional security. Thus, these tiny greens hold great potential as a future functional superfood.

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FROM HOMES TO HASHTAGS: HOW INDOOR PLANTS BECAME A MODERN LIFESTYLE

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Today, many people spend most of their time indoors – at home, offices, classrooms, restaurants, and shopping places. Modern city life and prolonged screen time cause stress, tiredness, and poor concentration in regular activities. Few studies show that people's lifestyles nowadays have limited or no contact with nature, which affects their mental status (Han and Ruan, 2019). Indoor plants are a simple solution to this problem. Researches show that even a small indoor plant can improve mood, reduce stress. Several studies report that people who work in a plant-filled environment feel more relaxed than in without plants. A 2014 study published in the Journal of Psychology reported that office productivity is increased by around 15 per cent when desk plants are placed. Small desk plants such as Pothos (*Epipremnum aureum*), ZZ plant (*Zamioculcas zamiifolia*), Jade plant (*Crassula ovata*), Peace lily (*Spathiphyllum spp.*), and Baby Rubber plant (*Peperomia obtusifolia*). In recent years, social media and trends have further increased the interest in indoor plants. During and after COVID-19, indoor gardening became a popular activity to reduce stress and improve mental well-being. This interest in people for indoor plants has further increased the demand for indoor plants and the significance of the floriculture industry in supplying plants suitable for modern indoor spaces.

Use of Plants in Reducing Stress

Modern life exposes people to constant mental pressure. Indoor plants help reduce stress by creating a natural and calming environment inside buildings (Han and Ruan, 2019). Simply being near indoor plants can lower psychological stress. People exposed to plants are reported to feel relaxed and emotionally comfortable (Rohman and Sugeng, 2023). People feel less mentally exhausted and more refreshed in environments that have greenery. This effect makes indoor plants an effective and low-cost method to manage daily stress in modern lifestyles (Han and Ruan, 2019).

People Plant Emotional Attachment

Indoor plants are not just decorative objects. Studies based on people's personal experiences show that care for plants creates a feeling of responsibility and attachment. Watching a plant grow, watering it regularly and keeping it healthy gives people a sense of achievement and satisfaction. For some individuals, plants become a part of their life, while for others, it is just a decorative item. This difference in people's care for plants explains why some carefully nurture their plants, while others lose interest over time.

Emotional bonding with plants is closely linked with mental well-being, which people experienced during the COVID-19 pandemic. That is when the emotional bond increased more, as access to the natural environment was limited. Many people looked at indoor plants as a way to cope with loneliness, anxiety, and boredom. Indoor plants help people feel connected to nature (Rohman and Sugeng, 2023).

Influence of Shopping Indoor Plants on Human Behaviour

Indoor plants not only improve the aesthetic value of a place but also influence how people behave in a place. Studies conducted in various places, such as shops, restaurants and other commercial spaces, show that customers respond more positively in the presence of indoor plants. People enter spaces that have plants because they feel inviting and less stressful. Not just enter but stay in there for a long time and feel more relaxed (Yildirim *et al.*, 2020). Plants also influence buying decisions – customers showed a willingness to buy food and beverages in shops designed with indoor plants than in plant-free places (Yildirim *et al.*, 2020).

Indoor plants reduce mental discomfort and help make decisions more comfortably. When people feel calm and positive, they are more open to exploring products, services hence customers tend to spend more time in shops (Han and Ruan, 2019). In recent years, social media is shaping consumer preference – people are more attracted to plant-filled cafes, shops and restaurants that are visually appealing and “Instagram worthy”. This encouraged businesses to use indoor plants as a part of their strategy to attract customers and improve their marketing (Han and Ruan, 2019). Recent studies show that farmers are more willing to market ornamental plants through social media when they are part of online communities. These platforms act as learning spaces where farmers gain confidence, improve digital skills, and receive social support, which helps them adopt online marketing and overcome market access limitations. (Nurfathiyah *et al.*, 2024)

Instagram plays a direct role in influencing the purchase of indoor plants by shaping consumer interest and confidence. Visual posts, reels, and stories show indoor plants in homes, making them attractive, easy to maintain, and suitable for modern lifestyles. Seeing other users successfully grow plants reduces fear of failure and encourages first-time buyers. Instagram also acts as an informal guide for consumers. Plant care videos, reviews, and recommendations from nursery pages and influencers help buyers choose suitable indoor plants and make easier decisions about their purchase. This visual exposure often converts interest into purchase behaviour.

Social Media Boosted Plant Culture

Social media is now playing a major role in increasing interest in indoor plants. Platforms like Instagram, Facebook and online marketplaces have changed how people discover, buy and explore plants. Research shows that social media influences people's interest in ornamental plants by making them more attractive. During COVID-19, people spent more time at home and online, scrolling social media that exposed them to indoor gardening ideas, plant care videos, and aesthetic home interiors filled with greenery. This encouraged people to buy plants to reduce stress, improve mood, and make their homes more aesthetic (Mubarok *et al.*, 2023).

Rare and visually attractive plants such as Pothos (*Epipremnum aureum*), Philodendron (*Philodendron hederaceum*), Bird's nest ferns (*Asplenium nidus*), Monstera (*Monstera deliciosa*), and Watermelon peperomia (*Peperomia argyreia*) gained popularity because they were frequently displayed online, which increased demand, market value and hence social media became an important marketing tool. Attractive images, live sales and interaction through social media help boost the ornamental plant sales (Mubarok *et al.*, 2023).



CN: Pothos
SN: *Epipremnum aureum*
F: Araceae



CN: Philodendron
SN: *Philodendron hederaceum*
F: Araceae



CN: Bird's nest ferns
SN: *Asplenium nidus*
F: Aspleniaceae



CN: Monstera
SN: *Monstera deliciosa*
F: Araceae



CN: Watermelon peperomia
SN: *Peperomia argyreia*
F: Piperaceae



CN: ZZ plant
SN: *Zamioculcas zamiifolia*
F: Araceae



CN: Peace lily
SN: *Spathiphyllum spp.*
F: Araceae



CN: Jade plant
SN: *Crassula ovata*
F: Crassulaceae



CN: Baby Rubber plant
SN: *Peperomia obtusifolia*
F: Piperaceae

Source: *Flowers of India, The Plant Kingdom*

Conclusion

Today, people spend most of their time indoors with limited contact with nature, which often leads to stress, reduced mental well-being. In recent years, social media, especially Instagram, has been playing an important role in changing the trends of purchasing plants and promoting ornamental plants as lifestyle products. Farmers show greater willingness to market ornamental plants through social media when they are connected to online communities, as these platforms provide learning, confidence, and support for effective online marketing. This growing interest has increased the demand for indoor plants and highlighted the importance of floriculture in supplying suitable, easy-to-maintain plants for modern indoor spaces.

Overall, indoor plants represent a meaningful link between nature, human well-being, and modern living. Their increasing use reflects a shift towards healthier indoor environments

and creates new opportunities for the floriculture industry to support sustainable urban lifestyles

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EMERGENCE OF RUGOSE SPIRALLING WHITEFLY AS A MAJOR THREAT TO COCONUT PLANTATIONS AND HORTICULTURAL CROPS

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Coconut, *Cocos nucifera* L. (Arecaceae) is an important plantation crop grown mainly in the tropical and subtropical areas of the world and most of the farmers depend on coconut both directly or indirectly for their livelihood. India is one of the leaders in coconut farming and stands third biggest coconut producing country worldwide. Amongst coconut producing states, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are the leading coconut producing states which account for more than 90% of coconut production.

Pest infestation is one of the main constraints for attaining better production and productivity in coconut. Coconut Eriophyid mite, *Aceria guerreronis* Keifer (Eriophyidae: Acarina), rhinoceros beetle, *Oryctes rhinoceros* L (Coleoptera: Scarabaieidae), pink palm weevil, *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae), black headed caterpillar, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) and white-grub, *Leucopholis coneophora* Burmeister (Coleoptera: Scarabaieidae) are considered as major pests of coconut.

Rugose Spiralling Whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) a new invasive pest was identified in India. Its invasiveness in India was recorded by the ICAR- National Bureau of Agricultural Insect resources, Bengaluru's scientists on coconut plantations at pollachi, Tamil Nadu (Sundararaj and Selvaraj, 2017) and subsequently, it has spread to districts of Karnataka, Kerala, Andhra Pradesh, Goa, Assam and West Bengal (Selvaraj *et al.*, 2017 & 2019) and it was recently located in Lakshadweep islands, coastal districts of Maharashtra, Gujarat, Telangana, Odisha, Chhattisgarh and few districts of Meghalaya and Assam. The incidence and infestation of the RSW was also recorded on many different Horticultural crops like oil palm, banana, guava, sapota, cashew nut etc. It has become

potential threat to Arecaceae family crops attacking more than 120 crops like ornamentals, palms, weeds, native and invasive plant species (stocks and Hodges, 2012).

Distribution

RSW is well distributed along coastal tracts, along the state, national highways, isolated gardens close to water bodies, back water regions and even in islands. The most insidious spread of RSW in India is probably mediated with the aid of people through the movement of infested seedlings and plant materials. Transportation of infested nursery planting material is number one thing which plays primary role in speedy dispersal of this pest within quick span of time.

Host Plants

RSW is a polyphagous pest, in India it was reported to feed approximately 44 host plants especially coconut, oil palm, banana, mango, sapota, guava, cashew, ramphal, maize, Indian almond, water apple, jack fruit and ornamental plants viz., bottle palm, Indian shot, false fowl of paradise and butterfly palm.

Biology

Egg stage: Adult female lays eggs in concentric circular or loose spiral pattern on the ventral surface of the leaves, on leaf petioles, stems and fruits. Eggs are elliptical and yellowish in colour, 0.3 mm long, translucent with a short stalk and are associated with abnormal spiralling deposits of white flocculent wax surrounding each egg in a semi-circular spiralling manner.

Nymph stage: The first instar nymphs are known as crawlers, which are only mobile stage with functional legs and these are transparent mild to golden yellowish in colour devoid of wax. second instar nymphs are immobile, fringed with marginal wax along the transverse grooves on their dorsum and the compound pores produce glassy wax filaments. They are transparent light to golden yellowish and bigger in size compared to first instar.

Third instar nymphs have numerous evenly spread short, glass rods like waxy filaments along the sides of body. Fourth instar nymphs are protected with copious quantity of opaque white waxy material dorsally as tufts.

Adult stage: Adults are about 3 times larger than the present invasive spiralling whitefly, *Aleurodicus dispersus* and are lethargic by nature. Adults can be distinguished by the presence

of a pair of irregular light brown bands across the wings. Males have long pincer-like structures at the distal ends of the abdomen.



Nature of Damage and Economic Significance

Both nymphs and adults suck the sap by using their piercing and sucking type of mouth parts from the abaxial surface of the coconut leaflets. De-sapping by RSW reduces the plant growth due to removal of water and vitamins. Massive feeding of the insect also leads in excretion of honey dew which subsequently gets deposited on the upper surface, lower surface of the leaves and on other feeding areas. Honey dew excrement, encourages the development of the fungus, *Capnodium ramosum* as a black encrustation, which causes the disfigurement of leaves, affecting the photosynthetic performance of the plant. Severe infestation causes stunted growth, premature leaf drying, dropping of fronds, immature nut fall and malformed nuts. White mealy waxy flocculent material produced by nymphs and adults causes nuisance to humans in severely infested areas.

IPM practices for the management of Rugose Spiralling Whitefly

Cultural practices:

- Field sanitation removal of weeds and other alternate host plants.
- Prevent transportation of infected planting materials.
- Provide balanced N:P:K fertilisers.
- Avoid high density planting.
- Intercropping with banana, pearl millet, cocoa and nutmeg to boost parasitoid activity in infected fields.
- Grow marigold as a intercrop to suppress the whitefly population. The limonene present in marigold flowers may repel the whiteflies. (Anon, 2019).

Mechanical practices:

- Spray water forcibly on the underneath surface of the fronds or on infected leaves to distort
- the whitefly population.
- Installation of yellow sticky traps.
- Periodically burn the badly infected leaves.

Biological practices:

- Field release of *Encarsia guadeloupeae* parasitoids by stapling the leaf with RSW puparia parasitized with *E. guadeloupeae*. To encourage the colonisation and multiplication of *E. guadeloupeae* in Indian shot, banana and annona flowers can be grown as intercrop.
- Release predator lace wing, *Chrysoperla spp.* or *Apertochrysa astur* @ 400 eggs/acre.
- Release sooty mildew feeding scavenging beetles, *Leiochrinus nilgirianus* Kaszab 1946 (Tenebrionidae : Coleoptera).
- Spraying of Entomopathogenic fungus, *Isaria fumosorosea* on the RSW causes yellow muscardine disease leading to mortality of the pest (Sandhu *et al.*, 2012).

Chemical practices:

- Apply of neem oil @10000 ppm by combining with washing powder to reduce RSW population (stocks & Hodges, 2012).

Conclusion and Future prospects

Rugose spiralling whitefly emerging as a severe threat to wide range of host plants, specifically coconut, oil palm, banana, citrus, and ornamental species. Its rapid reproduction, wide host range, and quick spread make it hard to control once established. While RSW is a significant threat, the pest is effectively managed through timely biological interventions and ecological monitoring. Several parasitoids like *Encarsia guadeloupeae* and *Chrysoperla*, Coccinellid predators have already shown effective control potential towards RSW. In areas, where these natural enemies establish well, RSW populations often drop significantly. Future pest infestation and damage will likely depend on how efficiently those biological controls are conserved and deployed.

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