Endophytes in Wheat and Their Possible Function in Abiotic Stress Management in a Changing Climate

Dhinu Yadav

ICAR-Indian Agricultural Research Institute, New Delhi-110012, India

Email: drdhinu@gmail.com

***Received:* Sept 09, 2021; *Revised:* Sept 11, 2021 *Accepted:* Sept 16, 2021**

ABSTRACT

In terms of soil type, temperature, pH, organic matter, moisture regime, and other factors, wheat (*Triticum aestivum* L.) cultivation varies greatly. Rising atmospheric temperature as a result of global warming is the most crucial of them, as it has a significant impact on grain yield. According to studies, for every 1°C increase in temperature beyond wheat's normal growing temperature range of 20-25°C, the grain filling period and kernel weight fall by 2.8 days and 1.5 mg, respectively, resulting in a wheat yield decline of 4-6 quintal per hectare. Growing food demand and the multifaceted effects of global warming may force wheat crops into heat stress situations, which can have a significant impact on heading duration, percent grain setting, maturity time, grain growth rate, and eventually total grain yield. There is a lot of genetic variety in the wheat gene pool when it comes to various qualities linked with high temperature stress tolerance, but only around 15% of it has been absorbed into cultivated wheat thus far. As a result, alternative solutions for sustainable, more productive, and environmentally friendly agriculture must be investigated and adopted. One realistic and environmentally beneficial approach is to look at microorganisms known as 'endophytes,' which colonise virtually all plant organs such as roots, stems, leaves, flowers, and grains without negatively influencing their growth. Under both biotic and abiotic stress circumstances, the relationship between plant and endophytes is critical for plant health, productivity, and overall survival.

Keywords: Bacteria, climate change, endophytes, wheat

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops, as it is consumed by roughly 40% of the global population and supplies a significant amount of protein (20%) and calories (19%). (Giraldo et al., 2019). Wheat is farmed on 221.85 million hectares around the world, with annual yields and productivity of 776.12 MT and 3.5 MT ha-1, respectively (USDA 2021). Wheat is grown in India in five agro-climatic zones, covering an area of around 29.8 million hectares and producing 103.59 MT annually. India is the world's second-largest producer of wheat. The problem of food insecurity may be exacerbated further by deteriorating soil health, sluggish crop yield and productivity, and climate vagaries, all of which are likely to increase with time. Increasing production under abiotic stress conditions is one of the most difficult recommendations among the various approaches tried to address this issue. Drought conditions infused by irregular rainfall and extraordinary temperature changes, particularly during the grain filling stage, are among the abiotic factors that have a significant impact on wheat grain production.

Seed germination is more sensitive to temperature changes in wheat agriculture, as it causes seed germination to be delayed due to decreased metabolic activity. Furthermore, delayed seed germination affects plant density and early crop establishment, whereas high temperatures at the anthesis stage and seed set reduce grain output significantly. In India, every 1°C increase in temperature reduces wheat productivity by 4-6 quintal per hectare, while every 2-3.5°C increase in temperature reduces przofit by 9-25 percent in rain-fed areas. Aside from heat stress, wheat crops growing in temperate and desert climates face cold stress as well. Crops exposed to very low and high temperatures suffer photosystem and enzyme degradation, resulting in decreased photosynthesis, plant growth, performance, and grain yield. It also has an effect on pollen quality, resulting in lower wheat seed set.

Drought is growing more frequent as a result of global warming, resulting in varying levels of output losses in various crops. Drought causes early vegetative growth and development, as well as late grain maturation, by altering osmatic pressure during wheat growth. It also impacts kernel counts and plant recovery during the reproductive stage of the crop through variations in leaf area index and dry matter accumulation. Around 90% of arable areas worldwide are vulnerable to temperature extremes or drought, which can result in yield losses of up to 70% in major food crops. More losses in the productivity of major crops such as rice, maize, and wheat are expected, according to predictions based on the integration of climate change and crop yield models (Table 1), which would have substantial implications for global food security (Tigchelaar et al., 2018).

Table:1. Yield losses in major cereal crops due to heat and drought stress

Crops	Abiotic stresses	Yield reduction (%)	References
Rice	Drought	53-92%	Lafitte et al. (2007)
	Heat	50%	Li et al. (2010)
Maize	Drought	63-87%	Kamara et al. (2003)
	Heat	42%	Badu-apraku et al. (1983)
Wheat	Drought	57%	Balla et al. (2011)
	Heat	31%	Balla et al. (2011)

Plant-microbes interactions

The plant-microbe symbiosis has a positive impact on plant growth and health, as well as reducing the negative effects of conventional agricultural techniques and enhancing soil health and nutrient cycling. Endophytes have higher influence among symbiotic microorganisms since they survive inside plant tissues without causing major damage to the plant or receiving further compensation other than establishing their residence. De Bary coined the word endophyte in 1866, however he identified the presence of fungus in wheat leaves much earlier, in 1846. Fungal and bacterial endophytes are fungus and bacteria that live within plant tissue without causing illness in their hosts. Endophytes are garnering increased attention in the scientific community due to their beneficial effects on plant quality and growth.

These have been researched primarily for their roles in nutrient provision, protection from biotic and abiotic stresses, adaptation to new environments, growth promotion, community biodiversity enhancement of host plants, and serving as a warden for microbial disease predators. In grass species, fungal symbionts promote vegetative growth in the rhizosphere by secreting secondary metabolites (gibberellins, auxins, and cytokinin). Plant Growth Promoting Fungi (PGPF) enhance plant growth by secreting enzymes such as ACC-Deaminase, catalase, urease, and others, as well as phosphate solubilization, siderophore and indole acetic acid synthesis, and phytopathogen antagonism. PGP endophytes that produce antibiotics can also be used as a source of biocontrol agents.

Endophytic microbes role in wheat

Endophytic bacteria can also exist as free-living organisms, either in a symbiotic connection with a plant's root surface or in the soil, and they play a crucial part in agricultural ecosystems. The microorganisms discovered in root tissue and the rhizosphere are quite comparable, showing that the rhizosphere is a major source of endophytic microbes and that roots are the primary entrance point for potential microbes from the soil to the host plant. Although these bacteria are usually genetically specific for plants, many studies have demonstrated that environmental factors, microbe-microbe interactions, and microbe-plant interactions all influence the composition of the endophytic population.

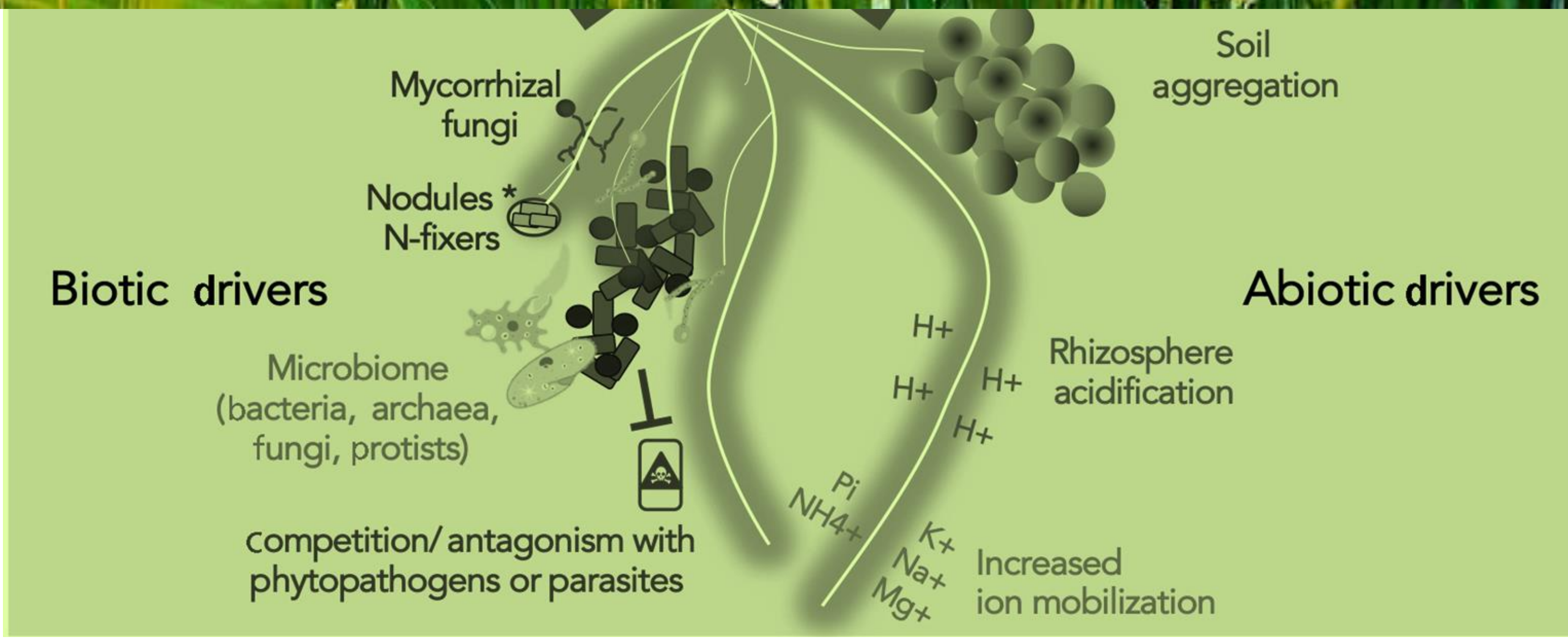
The activity of chemicals produced by both host plant cells and endophytic microorganisms mediates the intimate interaction between host plant and endophytic microbes. The microbial companion increases nutrition availability and absorption while also providing resistance to abiotic and biotic stressors. Plant growth is aided by endophytic microorganisms through direct and indirect mechanisms such as nitrogen fixation, phosphorus, potassium, and zinc solubilization, production of iron chelating molecules (siderophores), and secretion of various plant hormones (plant growth regulators) such as auxin, gibberellin, cytokinin, and ethylene.

Conclusion

Because they may be utilized as bio-fertilizers and bio-control agents, beneficial endophytic bacteria have a lot of potential to replace or reduce the use of artificial fertilizers and pesticides. A large number of plant endophytic bacteria have been found, with a diverse host range, and some of them have performed well in the field. Selectable endophytes have recently showed promise in improving wheat crop quality and productivity. Entophytes are vital in maintaining plant physiology and agro-ecosystem balance. Understanding the composition and function of wheat endophytes has a lot of potential for improving crop output in an environmentally responsible way as climatic circumstances change.

References

- De Bary, A. (1866). Morphology and physiology of fungi, lichens and myxomycetes. Leipzig: W. Engelmann
- Giraldo, P., Benavente, E., Manzano-Agugliaro, F. and Gimenez, E. (2019) Worldwide Research Trends on Wheat and Barley: A Bibliometric Comparative Analysis. *Agron* **9(7)**, 352.
- Tigchelaar, M., Battisti, D.S., Naylor, R.L. and Ray, D.K. (2018) Future warming increases probability of globally synchronized maize production shocks. *Proc Nat Acad Sci* **115(26)**, 6644-6649
- U.S.D.A. (2021) United States Department of Agriculture [Internet]. Available from: http://www.fas.usda.gov [Accessed: May 25, 2021]



Endophytes in Wheat