ISSN No:-2456-2165

Identifying the Impact of Nitrogen in Plant Disease Defenses Mechanism

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Abstract:- Diseases that affect crops in the agro-ecosystem endanger the safety and security of food supplies worldwide. An efficient and long-lasting strategy for managing plant diseases is to manipulate the target plants' built-in defence mechanisms. The growth along with development of plants mainly depends on the nitrogen. It is one of the most important macronutrients required for the synthesis of amino acids, proteins, nucleic acids, and many other important biomolecules. Besides its role in plant growth and development, nitrogen also plays a crucial role in the defense mechanism against disease in plants. Nitrogen is involved in the synthesis of defense-related compounds such as phytoalexins, pathogenesis-related (PR) proteins, and enzymes. These compounds play a vital role in plant defense against various pathogens. In general, N has positive effects on defence-related enzymes and proteins to influence both local defence and systemic resistance, but negative effects on physical defences and the production of anti-microbial phytoalexins. In this article, we will discuss the role of nitrogen in the defense mechanism against disease in plants.

***Keywords** :- Plant Disease, PR Protein, N, Defense Mechanism.*

I. INTRODUCTION

Plants are constantly under threat from a wide range of pathogens such as bacteria, fungi, viruses, and insects. These pathogens can cause serious damage to plants, resulting in reduced crop yields and economic losses. Therefore, plants have evolved a complex defense mechanism to protect themselves from these pathogens. This defense mechanism involves the synthesis of various defense-related compounds such as phytoalexins, PR proteins, and enzymes. Nitrogen plays a crucial role in the synthesis of these compounds, and thus, in plant defense against pathogens. The growth and evolution of plants as well as disease resistance and tolerance depend heavily on nutrients. (Huber and Haneklaus, 2007). The ability of the host plant to prevent the growth and reproduction of invasive pathogens is a measure of its resilience, whereas the host's ability to tolerate infection is a measure of its ability to maintain growth or yield. (Graham and Webb, 1991). Although the relationship between plants and pathogenic microorganisms is complicated, many environmental variables, including temperature, humidity, light, and nutrients, can have an impact. In this context, nitrogen (N), which makes up 1.5% to 2% of plant dry matter and 16% of all plant proteins, is especially significant as a macroelement necessary for normal plant growth and development (Scheible W.-R *et al*.). Key physiological or biochemical processes like photosynthesis, photorespiration, respiration, amino acid synthesis, and the tricarboxylic acid (TCA) cycle are connected to N assimilation. It is not unanticipated that a plant's N status can affect its resistance to a variety of abiotic and biotic stresses given how important it is to plant growth (Makino A, 2011). Even though the excess of N in plants is one of the most significant factors affecting disease growth, many studies remain obscure and contradict each other about the influence of N on disease production, and the reasons for this elusiveness were still little understood (Gupta *et al.*,2017). This review summarizes the relationship of N nutrition with the disease severity and its role in the defense mechanism.

II. ROLE OF NITROGEN IN PLANT DEFENSE MECHANISM

Nitrogen is a key element in the synthesis of amino acids, which are the building blocks of proteins. Proteins play a vital role in the plant defense mechanism against pathogens. For example, chitinases are PR proteins that hydrolyze the cell walls of fungal pathogens, whereas glucanases break down the glucans present in the fungal cell walls. Nitrogen is also involved in the synthesis of enzymes such as peroxidases, which are involved in the detoxification of reactive oxygen species (ROS) generated during the plant-pathogen interaction.

Besides its role in the synthesis of proteins and enzymes, nitrogen is also involved in the synthesis of phytoalexins, which are specialized metabolites produced by plants in response to pathogen attack. Phytoalexins play a vital role in plant defense against pathogens by inhibiting their growth and development. Nitrogen is a key element in the synthesis of these compounds, and the availability of nitrogen can significantly affect the synthesis of phytoalexins.

Nitrogen also plays a role in the regulation of the plant defense mechanism. Several studies have shown that the expression of defense-related genes is regulated by nitrogen availability. For example, the expression of genes encoding PR proteins and enzymes is upregulated under nitrogen deficiency, whereas the expression of genes involved in nitrogen assimilation is downregulated.

Table 1: Impacts of nitrogen on the severity of various crops' diseases:

Disease & Pathogen	Level of Infection	Conclusion
Stripe rust of wheat (*Puccinia striiformis f.sp. tritici)* [Devadas *et al.* (2014)]	greater severity during the grain filling step as a result of a higher nitrogen rate	The effect of susceptible rust variety yields and their relationship to reduced N intake are most likely related.
Obligate parasite (*Puccinia graminis*, *Erysiphe graminis*, *Oidium lycopercicum*) [Gupta *et al*. (2017); Hoffland *et al.* (2000); Agrios (2005)]	The severity of the disease is increased by high N supplies.	Obligate parasites need to ingest apoplast assimilates or living cells straight through a haustorium.
Powdery mildew of wheat (*Blumeria graminis*) [Chen *et al*. (2007)]	Due to a heavy application in N fertilizer, disease incidence (DI) and disease severity index (DSI) increased.	Severity can be influenced by biological control systems and the microclimate.
Leaf spot disease of wheat (*Pyrenophora tritici repentis*). [Krupinsky *et al.* (2007)]	It indicates that using adequate fertiliser in a no-till environment lowers the risk of leaf spot.	Lack of N or inadequate nutrition may promote the development of lesions.
Botrytis cinerea of tomato *Botryotinia fuckeliana* [Lecompte *et al.* (2010)]	Fertilizer lowers the susceptibility.	The development of isolates which are moderately aggressive but more effective against plant defence is hampered by a lack of substrate availability.
Rice Blast (*Magnaporthe oryzae*) [Huang *et al*. (2017)]	An increased N regime increased vulnerability.	Fungal pathogenicity programme translation defeated plant defence.

III. IMPACT OF NITROGEN CONCENTRATION AND AVAILABILITY ON PLANT DISEASE RESISTANCE

The concentration and availability of nitrogen have been found to affect the plant's susceptibility to diseases. High levels of nitrogen have been shown to increase the susceptibility of plants to certain diseases. This is because high nitrogen concentrations can lead to increased succulence and rapid growth, which can make plants more vulnerable to pathogen attack.

Conversely, low levels of nitrogen have also been found to decrease the plant's resistance to diseases. This is because nitrogen deficiency can limit the synthesis of defense compounds and weaken the plant's overall defense response.

IV. CONCLUSION

In conclusion, nitrogen plays a crucial role in the defense mechanism against disease in plants. Nitrogen is involved in the synthesis of defense-related compounds such as phytoalexins, PR proteins, and enzymes, which play a vital role in plant defense against various pathogens. Nitrogen also plays a role in the regulation of the plant defense mechanism by regulating the expression of defense-related genes. Therefore, the availability of nitrogen can significantly affect the plant's ability to defend itself against pathogens. Understanding the role of nitrogen in plant defense mechanism can help in the development of new strategies for plant protection and crop improvement.

REFERENCES

[1]. Agrios, G.N. (2005). Plant pathology 5th Edition. *Elsevier Academic Press.* Burlington, USA.
[2]. Anbessa, Yadeta. & Juskiw, Patricia. (2012). Review: Strategies to increase nitrogen use efficiency of spring barley. *Canadian Journal of Plant Science*, 92(4), 617–625.
[3]. Chen, Y. Zhang, F. Tang, L. Zheng, Y. Li, Y. Christie, P. & Li, L. (2007). Wheat powdery mildew and foliar N concentrations as influenced by N fertilization and belowground interactions with inter-cropped faba bean. *Plant and Soil*, 291, 1–13.
[4]. Devadas, R. Simpfendorfer, S. Backhouse, & D. Lamb, D.W. (2014). Effect of stripe rust on the yield response of wheat to nitrogen. *Crop Journal*, 2, 201–206.
[5]. Foyer, C.H. Noctor, G. & Hodges, M. (2011). Respiration and nitrogen assimilation: Targeting mitochondria-associated metabolism as a means to enhance nitrogen use efficiency. *Journal of Experimental Botany*, 62, 1467–1482.
[6]. Graham, R.D. & Webb, M.J. (1991). Micronutrients and disease resistance in plant. 2nd edition. 677 S. SegoeRd., Madison, WI 53711, USA*: Soil Science Society of America*. 4.
[7]. Gupta, N. Debnath, S. Sharma, S. Sharma, P. & Jyotika, P. (2017). Role of Nutrients in Controlling the Plant Diseases in Sustainable Agriculture. volume 2. *Springer Nature*, Singapore.
[8]. Gupta, N. Debnath, S. Sharma, S. Sharma, P. & Jyotika, P. (2017). Role of Nutrients in Controlling the Plant Diseases in Sustainable Agriculture. volume 2. *Springer Nature*, Singapore.

ISSN No:-2456-2165

[9]. Hoffland, E. Jeger, M.J. & Van Beusichem, M.L. (2000). Effect of nitrogen supply rate on disease resistance in tomato depends on the pathogen. *Plant and Soil*, 218, 239–247.

[10]. Huang, H. Nguyen, Thi. Thu. T, He, X. Gravot, A. Bernillon, S. Ballini, E. & Morel, J.B. (2017). Increase of fungal pathogenicity and role of plant glutamine in nitrogen-induced susceptibility (NIS) to rice blast. *Frontiers in Plant Science*, 8, 1–16.

[11]. Huber, D.M. & Haneklaus, S. (2007). Managing nutrition to control plant disease. *Landbauforschung Volkenrode*, 57, 313–322

[12]. Krupinsky, J.M. Halvorson, A.D. Tanaka, D.L. & Merrill, S.D. (2007). Nitrogen and tillage effects on wheat leaf spot diseases in the northern Great Plains. *Agronomy Journal*, 99, 562–569.

[13]. Lecompte, F. Abro, M.A. & Nicot, P.C. (2010). Contrasted responses of Botrytis cinerea isolates developing on tomato plants grown under different nitrogen nutrition regimes. *Plant Pathology*, 59, 891–899.

[14]. Makino, A. (2011). Photosynthesis, grain yield, and nitrogen utilization in rice and wheat. *Plant Physiology*, 155, 125–129.

[15]. Scheible, W.R. Morcuende, R. Czechowski, T. Fritz, C. Osuna, D. Palacios-Rojas, N. Schindelasch, D. Thimm, O. Udvardi, M.K. & Stitt, M. (2004). Genome-wide reprogramming of primary and secondary metabolism, protein synthesis, cellular growth processes, and the regulatory infrastructure of Arabidopsis in response to nitrogen. *Plant Physiology*, 136, 2483–2499.