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Review Article

Methods and Biological Factors Affecting For Plant Microbes and Stomal Interaction, Seed Hybrid Technology through Genetic Engineering

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Abstract

Stomata are made up of pairs of special epidermis cells called guard-cells. Stomata control the loss of water and monitor the gas exchange between the environment and plant by adjusting stomatal pores size. Stomata closure is a common response of plants when they are attacked by herbivores. Long-term or extreme water-stress in the orange trees can result in leaf drop, continuous branch tips drying, and a substantial decrease in the yield of fruit owing to fruit and also flowers abscission. The tissues of leaf can become susceptible to a bacterial incursion during the period of strong photosynthetic-activity and the transpiration, as that physiological process depends on the extensively opened stomata. Genomic editing is a revolutionary technique that allows the scientists to produce new crop types with the greater precision and focus. Modifications that were made previously by the traditional breeding can now be made more easily and quickly using genomic editing tools. Viral infections are hard to control, and the chemical treatment does not eliminate them. Many of the deadly and commercially significant viral infections in the crops can benefit from the use of GE technology to develop viral intervention tactics.

Keywords: Stomata, plant cell interaction, microbes, transgenic technology, genetic engineering.

INTRODUCTION

Stomata can react to a wide-range of stimuli in the environment. They open in the presence of RH (higher relative humidity) and light, but closed during nighttime, drought, lower RH and the stress responsive phytohormone ABA [1-3]. Stomata closure is a common response of plants when they are attacked by herbivores. Herbivory can cause the loss of water by making open-wounds which increase the transpiration rate (chewing-herbivores), damaging root systems and liquid elimination from the vascular tissues (piercing herbivores). Long-term or extreme water-stress in the orange trees can result in leaf drop, continuous branch tips drying, and a substantial decrease in the yield of fruit owing to fruit and also flowers abscission. The rapid and extreme water stress can produce even more disastrous consequences like dehydration of cell and xylem embolism [4-7].

Stomata are made up of pairs of special epidermis cells called guard-cells. Stomata control the loss of water and monitor the gas exchange between the environment and plant by adjusting stomatal pores size. Multiple environmental factors influence stomatal mobility, including RH (relative humidity), Carbon dioxide concentration, and the intensity of light. JA signaling, like the ABA signaling system, has been extensively studied, especially in relation to stress responses. Whereas the relationship between JA and ABA signaling pathways for stomatal functions has been documented, there is more need of research and identification of nodes which connect these two signaling pathways, like CPK6, is still needed [8-12].

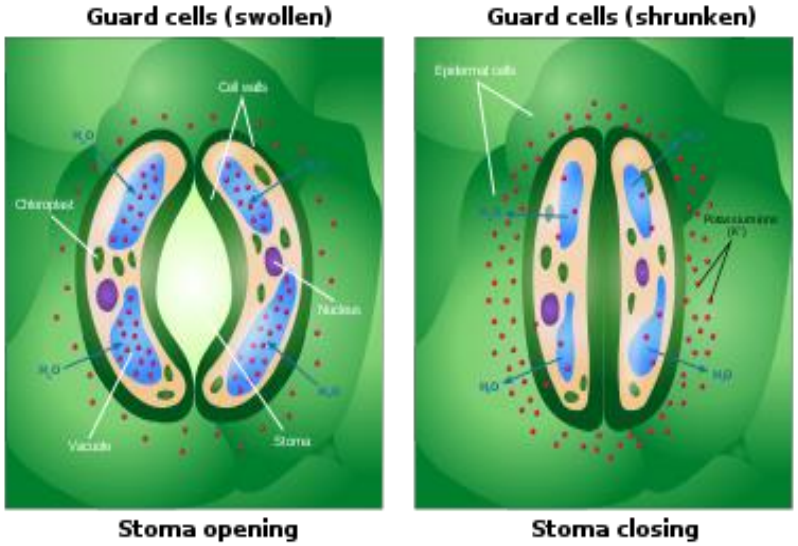

Fig 1: Shows the functioning of stomata with opening and closing of guard cells

Stomal interaction, seed hybrid technology through genetic engineering

Several external and internal (hormonal) stimuli regulate the stomatal development. Since the discovery of core stomatal signal transduction pathways and the master regulators of the stomatal differentiation, researchers have been working hard to figure out how these many inputs enter into the main stomatal pathways. However, several questions still remain unanswered. As various environmental abiotic factors encourage stomatal closure (e.g., darkness, low humidity, low temperature, high CO2 one would anticipate these factors to impede disease entry in to the leaves, unless the pathogens have acquired the ability to overcome these factors. For example, many terrestrial plants close their stomata during night time, potentially reducing pathogenic infection. Moreover, when compared to plants treated under light, the COR-deficient mutant Pst DC3118 colonizes leaf apoplast less effectively in dark [13, 14-17].

Bacteria can also enter the plant body through stomata. The tissues of leaf can become susceptible to a bacterial incursion during the period of strong photosynthetic-activity and the transpiration, as that physiological process depends on the extensively opened stomata. To hinder the microbial attack by these pits, plants have formed classy mechanisms which perceive the microbial attacks and close stomata, a resistance strategy typically stated as stomatal-immunity [18-21].

Because of their uncertain flowering habits, seeds production for such crops can be difficult. At a specified time during the production, these unspecified species will have mature, over mature, immature and seeds shattering present instantaneously. Due to the immaturity, early seed harvesting might lead to poor seed-quality and limited germination. The soaking concentration and duration of most priming approaches, such as osmo-priming and on farm priming, have been improved for various crops. For biochemical-priming, polyamines together with spermine, putrescine and spermidine, NaCl, CaCl2, KNO3, KCl, KH2PO4, PEG, hydro absorbers like biplantol and humic-acid for grains coating and naturally occurred molecules like NO, ascorbate, H2S, indoleamine molecule melatonin, H2O2, salicylic acid, and lately growth endorsing cytokinin rich moringa leaf's extracts are usually being assessed [21-24].

Seeds are immersed in a nutrient rather than pure water in "nutrient-seed-priming" to boost the seed nutritional content and priming influence, which enhances the germination rate and establishment of seedling. It was investigated that the priming of maize seeds with CaCl2 improve the final germination-rate, and dry and fresh biomass of the radicles and plumules, compared to control and water primed seed under the salt-stress. For the most corporate crop production, establishing a good seedlings stock is a necessity for better yield and the quality propagating material, and excellent seed quality assurance is thus critical for long-term crop production [25-27].

For the next year of seed sowing proper harvesting, grains processing and proper storage is necessary for the seed protection so that the seeds grow properly. The multiplication of new enhanced varieties and more care by various grades of multiplying should be reserved to keep novel varieties from mixing and loss of their purity or genetical during their cycle procession. Magnet stimulation of seeds includes detecting the magnetically exposure dose to affect seed germination, premature growth of seedling and yield of succeeding crop. The magnet exposure dosage is

product of flux-density of the magnetic field. The flux-density of the magnetic field changes with the altering or static magnetic field exposure to grains [28-30].

Naturally, the phytopathogen Xanthomonas forms TALEs (TAL effectors), that enters in nucleus of plant cell and re-program the transcription-machinery and is beneficial the for pathogen. They work as the eukaryotic transcription factor by connecting with the promotor region and activate the expression of genes. Techniques to apply water deficit and managing the plant water level are critical for testing GM-plants in order to generate 'DR' plants. Until date, it has been evident that performance of plant evaluation procedures and criteria have been a secondary priority in GM research; the fundamental concern has been the mechanism of transformation [31-34].

Genomic editing is a revolutionary technique that allows the scientists to produce new crop types with the greater precision and focus. Modifications that were made previously by the traditional breeding can now be made more easily and quickly using genomic editing tools. Genetically-modified (GM) involves transfer of genetic material between the species utilizing a variety of laboratory procedures such as genes cloning, splicing of DNA segments altogether, and injecting genes in to the cells. Communally, these practices are acknowledged as recombinant-DNA-technology [36-38].

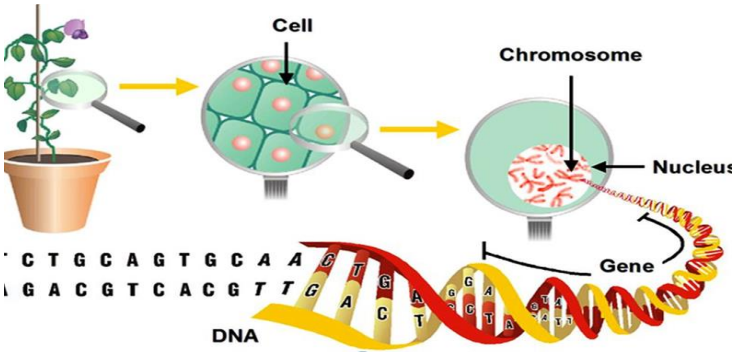

Fig 2: Shows the principles of genetic engineering with recent advances

A common vector has three parts: a replication origin, a multicloning-site or recombination-site, and a selectable-marker. An AT-rich area on vector starts the replication by attaching to a protein complex, un-winding the vector, and then replicating it by the help of polymerases. The multicloning-site is a segment which comprises numerous distinct sequences, also referred as restriction sites, which can be cleaved by a particular enzyme called restriction enzyme, enabling the introduction of desired gene. Site specific recombination among two plasmids is possible due to the recombinant site [1, 8-10].

Plant breeders frequently aim to integrate the beneficial characteristics of the two plants. For instance, the breeders insert the disease resistant genes from the one plant to the other plant which yields more but disease vulnerable, whereas parting behind any of the unwanted genetic character of disease resistive plant, such as the underprivileged fertility and the grain yield, vulnerability to diseases, or production of anti-nutritional metabolites [21, 23, 28].

Viral infections are hard to control, and the chemical treatment does not eliminate them. Many of the deadly and commercially significant viral infections in the crops can benefit from the use of GE technology to develop viral intervention tactics. For example, detoxifying the pathogen virulence determinants, overexpression of resistance (R) and the pathogenesis related (PR) genes, increased structural inequalities, and change of defensive scheme systems have all been used to promote resistance to disease in transgenic-plants. Some Cas9 variations exclusively cleaved complementary or non-complementary helix of target DNA at one location (nickase). With the lower levels of NHEJ-indels, the Cas9 nickase causes HDR. More than 1 location can be target and changed at the same time utilizing one Cas9 nuclease and numerous gRNA. When the one gRNA is ineffective at disrupting a particular gene or when changing multiple genes at once, this method proves useful [34, 35, 37].

The exclusion of transgenes would also ease the concerns about the genomic edited plants. The regeneration of mutated plants without selective pressures is one method for accomplishing this goal. Nevertheless, this method is very difficult and time taking because the efficacy with which the transgene free mutated-plants can be attained is very low. The repair of the DNA breakage caused by nucleases is a critical stage in genomic editing process. Endogenous-cellular methods repair DNA breaks: non-homologous end joining (NHEJ) or homology-dependent-repair (HDR). NHEJ is modest mechanism where the ends of cut DNA are linked together, frequently resulting in addition or the deletion of the nucleotides in that way shifting the genes reading frame, ensuing in a gene knockout [1, 6, 9, 19, 20].

DNA techniques based on the DNA biomarkers, genetic manipulation, and expression of genes have all been extensively used in the food production and have shown excessive potential for enhancing agriculture quality and yield, limiting the losses caused by abiotic and biotic stresses, facilitating the genomic resource usage, improving the breeding competence, and reinforcing plant growth regulation. The organisms commonly used in bio-remediation are Nitrosomonas europaea and pseudomonas putida. To separate the original gene situated in these bacteria which endorse the bioremediation, then alter and integrate them in to appropriate host to be utilized as a bio-remediation mediator frequently *E. coli* is the main objective [38-40].

After bacteria the work on plants is harder, genes insets can be completed in to single-plant cells. Then, cells can be cultured to grow a matured plant. The main technique for introducing genes is done by the plasmid of bacterium called Agrobacterium-tumefaciens. This bacteria attacks plant cells, and then insert its plasmid in to the chromosomes of plant carrying genes for tumor initiation. Scientists eliminate tumors making genes and get a plasmid which ties with plant cells without any injury [41-43].

CONCLUSION

The importance of investigating the complicated structure of drug metabolizing enzymes associated with drug metabolism is critical for optimal efficiency and effects of medications. Heterologous-expressions, in which the enzyme genetic makeup is expressed in-vitro or in-vivo via gene flow, has recently played a role in the recombinant DNA techniques. Transgenic-plants are genetically altered plants that carry foreign genetic material. This recombinant-DNA technology can help with resistance to disease, pests and insects' resistance, drought-tolerance, herbicides and pesticides tolerance, metal toxicity tolerance, male sterility introduction for the plant breeding, and the quality enhancement. BT cotton, resilient to bollworms is evident example.

REFERENCE

1. Aung, K., Jiang, Y., & He, S. Y. (2018). The role of water in plant–microbe interactions. *The Plant Journal*, *93*(4), 771-780.
2. Cheng, Y. T., Zhang, L., & He, S. Y. (2019). Plant-microbe interactions facing environmental challenge. *Cell host & microbe*, *26*(2), 183-192.
3. Elmore, J. M., & Coaker, G. (2011). The role of the plasma membrane H+-ATPase in plant–microbe interactions. *Molecular plant*, *4*(3), 416-427.
4. Wang, R., Wang, M., Chen, K., Wang, S., Mur, L. A. J., & Guo, S. (2018). Exploring the roles of aquaporins in plant–microbe interactions. *Cells*, *7*(12), 267.
5. Allègre, M., Daire, X., Héloir, M. C., Trouvelot, S., Mercier, L., Adrian, M., & Pugin, A. (2007). Stomatal deregulation in Plasmopara viticola-infected grapevine leaves. *New phytologist*, *173*(4), 832-840.
6. Zeng, W., Melotto, M., & He, S. Y. (2010). Plant stomata: a checkpoint of host immunity and pathogen virulence. *Current opinion in biotechnology*, *21*(5), 599-603.
7. Ulrich, D. E., Sevanto, S., Ryan, M., Albright, M. B., Johansen, R. B., & Dunbar, J. M. (2019). Plant-microbe interactions before drought influence plant physiological responses to subsequent severe drought. *Scientific reports*, *9*(1), 1-10.
8. Sakata, N., Ishiga, T., Masuo, S., Hashimoto, Y., & Ishiga, Y. (2021). Coronatine contributes to Pseudomonas cannabina pv. alisalensis virulence by overcoming both stomatal and apoplastic defenses in dicot and monocot plants. *Molecular Plant-Microbe Interactions*, (ja).
9. Wu, L., Huang, Z., Li, X., Ma, L., Gu, Q., Wu, H., ... & Gao, X. (2018). Stomatal closure and SA-, JA/ET-signaling pathways are essential for Bacillus amyloliquefaciens FZB42 to restrict leaf disease caused by Phytophthora nicotianae in Nicotiana benthamiana. *Frontiers in microbiology*, *9*, 847.
10. Spence, C., & Bais, H. (2015). Role of plant growth regulators as chemical signals in plant–microbe interactions: a double edged sword. *Current opinion in plant biology*, *27*, 52-58.
11. Bergmann, D. C., & Sack, F. D. (2007). Stomatal development. *Annu Re. Plant Biol*, *58*, 163-181.
12. Pang, Q., Zhang, T., Zhang, A., Lin, C., Kong, W., & Chen, S. (2020). Proteomics and phosphoproteomics revealed molecular networks of stomatal immune responses. *Planta*, *252*(4), 1-17.
13. Yan, J., Yu, H., Li, B., Fan, A., Melkonian, J., Wang, X., ... & Hua, J. (2019). Cell autonomous and non-autonomous functions of plant intracellular immune receptors in stomatal defense and apoplastic defense. *PLoS pathogens*, *15*(10), e1008094.
14. Baker, C. M., Chitrakar, R., Obulareddy, N., Panchal, S., Williams, P., & Melotto, M. (2010). Molecular battles between plant and pathogenic bacteria in the phyllosphere. *Brazilian Journal of Medical and Biological Research*, *43*, 698-704.
15. Montano, J., & Melotto, M. (2017). Stomatal bioassay to characterize bacterial-stimulated PTI at the pre-invasion phase of infection. In *Plant pattern recognition receptors* (pp. 233-241). Humana Press, New York, NY.
16. Cao, F. Y., Yoshioka, K., & Desveaux, D. (2011). The roles of ABA in plant–pathogen interactions. *Journal of plant research*, *124*(4), 489-499.
17. Tateda, C., Obara, K., Abe, Y., Sekine, R., Nekoduka, S., Hikage, T., ... & Fujisaki, K. (2019). The host stomatal density determines resistance to Septoria gentianae in Japanese Gentian. *Molecular Plant-Microbe Interactions*, *32*(4), 428-436.
18. Gayatri, G., Agurla, S., Kuchitsu, K., Anil, K., Podile, A. R., & Raghavendra, A. S. (2017). Stomatal closure and rise in ROS/NO of Arabidopsis guard cells by

tobacco microbial elicitors: cryptogein and harpin. *Frontiers in plant science*, *8*, 1096.
19. Zeng, W., Brutus, A., Kremer, J. M., Withers, J. C., Gao, X., Jones, A. D., & He, S. Y. (2011). A genetic screen reveals Arabidopsis stomatal and/or apoplastic defenses against Pseudomonas syringae pv. tomato DC3000. *PLoS pathogens*, *7*(10), e1002291.
20. Etesami, H., & Beattie, G. A. (2017). Plant-microbe interactions in adaptation of agricultural crops to abiotic stress conditions. In *Probiotics and Plant Health* (pp. 163-200). Springer, Singapore.
21. Nadeau, J. A., & Sack, F. D. (2002). Control of stomatal distribution on the Arabidopsis leaf surface. *Science*, *296*(5573), 1697-1700.
22. Prats, E., Gay, A. P., Mur, L. A., Thomas, B. J., & Carver, T. L. (2006). Stomatal lock-open, a consequence of epidermal cell death, follows transient suppression of stomatal opening in barley attacked by Blumeria graminis. *Journal of Experimental Botany*, *57*(10), 2211-2226.
23. Hok, S., Attard, A., & Keller, H. (2010). Getting the most from the host: how pathogens force plants to cooperate in disease. *Molecular plant-microbe interactions*, *23*(10), 1253-1259.
24. Kushwaha, S., Kumar, N., Thakur, B., Singh, N. K., & Bisht, D. S. (2021). Role of Functional Defence Signalling Molecules in Plant–Microbe Interactions. In *Microbial Metatranscriptomics Belowground* (pp. 199-218). Springer, Singapore.
25. Gupta, K. J., & Igamberdiev, A. U. (Eds.). (2015). *Reactive oxygen and nitrogen species signaling and communication in plants*. Springer International Publishing.
26. Binyamin, R., Nadeem, S. M., Akhtar, S., Khan, M. Y., & Anjum, R. (2019). Beneficial and pathogenic plant-microbe interactions: A review. *Soil & Environment*, *38*(2).
27. Kannojia, P., Sharma, P. K., Kashyap, A. K., Manzar, N., Singh, U. B., Chaudhary, K., ... & Sharma, S. K. (2017). Microbe-mediated biotic stress management in plants. In *Plant-Microbe Interactions in Agro-Ecological Perspectives* (pp. 627-648). Springer, Singapore.
28. Pillitteri, L. J., & Dong, J. (2013). Stomatal development in Arabidopsis. *The Arabidopsis book/American Society of Plant Biologists*, *11*.
29. Knoll, D., & Schreiber, L. (2000). Plant–microbe interactions: wetting of ivy (Hedera helix L.) leaf surfaces in relation to colonization by epiphytic microorganisms. *Microbial ecology*, *40*(1), 33-42.
30. Singh, B. K., Millard, P., Whiteley, A. S., & Murrell, J. C. (2004). Unravelling rhizosphere–microbial interactions: opportunities and limitations. *Trends in microbiology*, *12*(8), 386-393.
31. Choudhary, K., Vivekanand, V., & Pareek, N. (2021). Phytohormones as Fundamental Regulators of Plant–Microbe Associations Under Stress Conditions. In *Plant, Soil and Microbes in Tropical Ecosystems* (pp. 203-226). Springer, Singapore.
32. Bilgin, D. D., Aldea, M., O'Neill, B. F., Benitez, M., Li, M., Clough, S. J., & DeLucia, E. H. (2008). Elevated ozone alters soybean-virus interaction. *Molecular Plant-Microbe Interactions*, *21*(10), 1297-1308.
33. Southgate, E. M., Davey, M. R., Power, J. B., & Marchant, R. (1995). Factors affecting the genetic engineering of plants by microprojectile bombardment. *Biotechnology Advances*, *13*(4), 631-651.
34. Yang, J. F., Hao, G. F., & Yang, G. F. (2021). Genetic Engineering and Chemical Control Related to Abscisic Acid for Improving Plant Drought Tolerance.
35. Kadapatti, S. S., & Murthy, H. N. (2021). Rapid plant regeneration, analysis of genetic fidelity, and neoandrographolide content of micropropagated plants of Andrographis alata (Vahl) Nees. *Journal of Genetic Engineering and Biotechnology*, *19*(1), 1-8.
36. Zhang, Y., Iaffaldano, B., & Qi, Y. (2021). CRISPR ribonucleoprotein-mediated genetic engineering in plants. *Plant Communications*, 100168.
37. Lyu, M., Kong, L., Yang, Z., Wu, Y., McGhee, C. E., & Lu, Y. (2021). PNA-Assisted DNAzymes to Cleave Double-Stranded DNA for Genetic Engineering with High Sequence Fidelity. *Journal of the American Chemical Society*.
38. Kumar, A. U., & Ling, A. P. K. (2021). Gene introduction approaches in chloroplast transformation and its applications. *Journal of Genetic Engineering and Biotechnology*, *19*(1), 1-10.
39. Desgagné-Penix, I. (2021). Biosynthesis of alkaloids in Amaryllidaceae plants: A review. *Phytochemistry Reviews*, *20*(2), 409-431.
40. Lamboro, A., Song, B., Songnan, Y., Han, X., Mingguo, H., Li, X., ... & Zhang, J. (2021). Genetic engineering and genome editing techniques in peanut plants. *Plant Science Today*, *8*(3), 528-534.
41. Klink, V. P., Darwish, O., Alkharouf, N. W., & Lawrence, K. S. (2021). The impact of pRAP vectors on plant genetic transformation and pathogenesis studies including an analysis of BRI1-ASSOCIATED RECEPTOR KINASE 1 (BAK1)-mediated resistance. *Journal of Plant Interactions*, *16*(1), 270-283.
42. Demirer, G. S., Silva, T. N., Jackson, C. T., Thomas, J. B., Ehrhardt, D. W., Rhee, S. Y., ... & Landry, M. P. (2021). Nanotechnology to advance CRISPR–Cas genetic engineering of plants. *Nature Nanotechnology*, *16*(3), 243-250.
43. Liana, D., & Rungsihirunrat, K. (2021). Phytochemical screening, antimalarial activities, and genetic relationship of 16 indigenous Thai Asteraceae medicinal plants: A combinatorial approach using phylogeny and ethnobotanical bioprospecting in antimalarial drug discovery. *Journal of Advanced Pharmaceutical Technology & Research*, *12*(3), 254.