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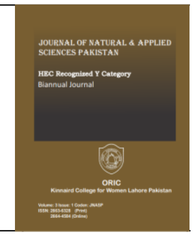

DO PLANTS REALLY COMMUNICATE WITH THEIR NEIGHBOR? A SHORT COMMUNICATION

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Abstract

Due to the evolution process plants have made such a sophisticated mechanism by which they can communicate with their neighboring individuals via airborne and root secretions. This process can support their nutrient acquisition or induced resistance to disease and herbivores; some of them evolve in more constructive ways, such as during stressful periods, the damaged plants may caution other conspecifics in the close vicinity, or elicit chemical change in the undamaged ones. This short review highlights the recent studies to deepen understanding of the chemical response and communication between the neighboring plants. This study finds that plants have the ability to communicate with each other neighboring plants in the close vicinity but more studies on molecular and protein interaction should be conducted to support this mechanism.

1. Introduction

The initial perception of plant communication through volatile cues witnessed dates back to 1983 when two different research factions (Baldwin & Schultz, 1983) working autonomously in two different laboratories observed that plants grown in close proximity to damaged neighbors became more resilient or chemically more protected against herbivorous attack than those which grown at some distance away from damaged plants or grown nearby undamaged neighbors. From then on, this mechanism has been generally entitled as ‘talking trees’ phenomenon. Differing to animals, plants are rooted, immovable creatures. Even though plant growth may only tend towards the sun and may bend with the effect of gravity, they cannot travel around in search of food or breeding nor rescue themselves in danger from their predators like multicellular eukaryotic organisms (animals). That is why plants have evolved some sophisticated mechanisms for their survival in nature. To date numerous studies revealed that both plants and animals utilize internal chemical transmission to manage the form and mechanism of different parts of the same individual (intra-species communication) (Dubey *et al.,* 2002; Snow, 1931).

Plants discharge a disparate variety of volatile organic compounds (VOCs) into adjacent vicinity of their neighbors, with the remarkable change in VOCs emission patterns against biotic and abiotic stress environments (Naeem *et al.,* 2015). As concerns to biotic stress, herbivore damage or pathogen attack frequently urges plants to boost up volatile organic compounds (VOCs) emissions to warn neighboring plants, whereas stress-induced VOC emissions reduction may possibly occur in some cases. Up to now, more than 1700 volatile organic compounds (i.e. secondary metabolites) have been classified as diffused by plants under several circumstances, predominantly constitute of green leaf volatiles (GLVs), fatty acid derivatives such as terpenoids and benzenoids (Dudareva & Klempien, 2013). These VOCs perform an integral part in the plant-plant interactions and their associated populations, including inter plants and intra/inter plant communication (Heil, 2014). For instance, herbivore or mechanically damaged plant may induce VOCs which can invite the higher insects in the trophic level which are the natural enemies of the attacking herbivores. A mechanism denoted as ‘plants asking for rescue’ or indirect defense mechanism (Heil, 2014). The damaged plants not just emit volatile organic compounds to save themselves but they may also send and receive warning cues from neighboring plants to induce defense mechanism in undamaged plants to avoid possible herbivore attack (Richard Karban *et al.,* 2006). From previous studies it is evident that plant can secrete different kind of volatile compounds when they are in stressful condition and they can transmit the information in the neighboring plants as well.

Plants show phenotypic plasticity in response to the signals and cues they obtain from competitors under different biotic and abiotic environments. Due to the flexibility of the root adaptation to different environments, plants can facilitate neighbors, resist neighbors, or tolerate neighbors at belowground interaction, and plants will adjust resources distribution aboveground or belowground accordingly. A lot of experimental studies suggested that plants can modify their root growth in the presence of different neighbors, which indicated that identity recognition in the plants also have a great significance for the outcome of belowground interactions.

Active communication between damaged (emitter) and undamaged (receiver) plants after herbivore attack has been observed in many species like Nicotiana attenuata, Salix sitchensis and Phaseolus lunatus (Baldwin & Schultz 1983; Heil & Silva Bueno 2007; Halitschke *et al*. 2008; De Moraes *et al*. 2011). Different defensive chemicals such as secondary metabolites (i.e. green leaf volatiles (GLVs), fatty acid derivatives such as terpenoids and benzenoids) are released by the damaged plants towards undamaged one. This volatile organic compound (VOC) communication between the plants play integral part in plant-plant interaction and need to be studied in various species for better understanding of plant interaction and communication.

After so long time of research, questions about species interaction and coexistence continue to attract researchers. Understanding about the plant interaction is not only a continuing intellectual puzzle, but it can also help to address manage the problems including the conservation of different plant species, the control of biological invasions, and the forecasting of the impacts of climate change. More studies related to plant interaction with reference to species recognition may also help the ecologist to understand species coexistence in a better way. In fact, the overall niche difference between a pair of species can be defined as a ratio of interspecific/intraspecific competition coefficients. When interspecific competition is weaker than intraspecific competition, each species in a community restricts its own population growth more than it limits the population growth of its competitors but in case of kin selection and species recognition this mechanism may modified.

2. Conclusion

Belowground root-root interaction secrete thousands of various compounds, which are generally classified as glucose, amino acids, organic acids, fatty acids, proteins, and etc. (Bais *et al.*, 2006; Dennis *et al.*, 2010). These compounds behave differently in the rhizosphere under different biotic and abiotic conditions (Badri & Vivanco, 2009). The root-root interaction depends on many external elements, such as plant size, photosynthetic activity, density of the plants and nutrient availability, as well as depend on the neighbor species identity such as (conspecific/heterospecific) or even at genetic relatedness (Semchenko *et al.,* 2014). According to previous studies, roots of different individuals either conspecific or heterospecific plants have the ability to integrate detailed information about their neighbors (Schoeb *et al.*, 2015; Wu *et al.,* 2013).

Due to root-root interaction and root exudates nutrient availability may be affected (Hawkes *et al.,* 2005; Hinsinger *et al.,* 2009) and consequently, have the potential to trigger nutrient competition. As the whole nutrient availability, neighbor's identities and root interaction with different level play a significant role in plant interaction. Former research conducted on plant kin recognition and competition have shown that, plants have the ability to recognize other plants in their surroundings based on genetic relatedness and species identity as conspecific or heterospecific neighbors. To date, the field of plant kin and species recognition have met with several inconsistent findings and conflicting results, some studies resulted in favor of the kin recognition phenomenon (Bhatt *et al.,* 2011; Biedrzycki & Bais, 2010; Crepy & Casal, 2016; Donohue, 2003; Dudley & File, 2007; Murphy & Dudley, 2009; Semchenko *et al.,* 2014), other established contrasting results (Cheplick & Kane, 2004; Mercer & Eppley, 2014), and some studies concluded with no significant variation between sibling conspecific and non-sibling conspecific groups (Lepik *et al.,* 2012; Milla *et al.,* 2012; Monzeglio & Stoll, 2008; Puustinen *et al.,* 2004; Willis *et al.,* 2010).

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