AN OVERVIEW ON THE MOLECULAR ASPECT OF HERBIVORE - PLANT INTERACTION: A REVIEW

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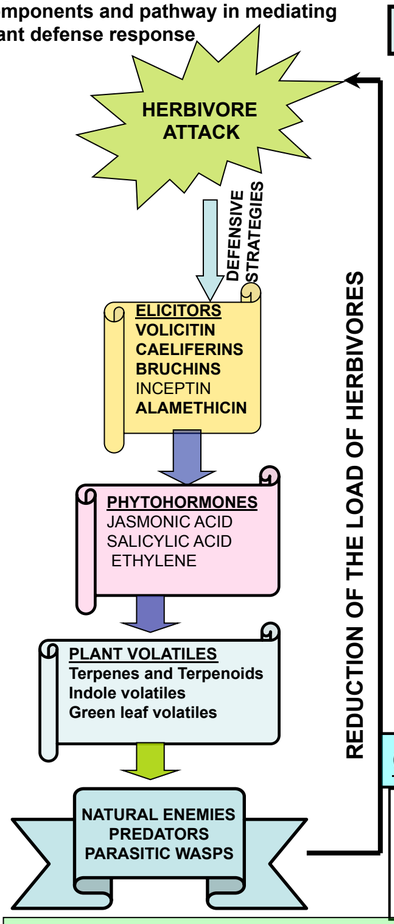
INTRODUCTION

Several decades of studies on co-evolution and co-interaction between plant and insect-herbivores has lead to the generation of a sophisticated mechanism to overcome each other. Recent advances in molecular biology techniques have provided insight into different mechanisms underpinning such interaction.

Plants are known to receive such herbivore associated or other damage induced signals and react accordingly.

Plant-herbivore recognition mechanism involves: Binding of Herbivore-Associated--Molecular-Patterns (HAMP) and Damage-Associated-Molecular-Patterns (DAMP) from insects to Pattern Recognition Receptors (PRR) on plant species.

Figure: Schematic representation of components and pathway in mediating plant defense response



ELICITORS—INDUCTION OF PLANT DEFENSIVE RESPONSE

VOLICITIN	CAELIFERINS	BRUCHINS	INCEPTIN	ALAMETHICIN
Isolated from oral secretion of *Spodoptera exigua* They possess widest range of phytohormone and volatile-induced activity in maize, brinjal and soyabean	Isolated from regurgitant of *Schistocerca* Induces the production of JASMONIC ACID & ETHYLENE in *Arabidopsis*	Produced in insects and released into plant tissues on egg deposition Stimulates neoplastic growth of undifferentiated cells beneath the point of egg, affecting larval entry in plant tissues	Derived from plant chloroplastic ATP sythase g-subunit on entry into insect gut and subsequently converted into inceptin through proteolytic reaction	Produced in fungus *Trichoderma viride* Known to initiate formation of voltage dependant ion channel leading to cell membrane depolarization leading to release of insect induced plant volatiles.

PHYTOHORMONES –AS MEDIATORS OF DEFENSIVE REACTION

JASMONIC ACID (JA)	SALICYLIC ACID (SA)	ETHYLENE
Synthesized in chloroplast membrane in response to herbivory thereby strongly attracting predators and parasitoids of insects	Essential role in plant growth and development and indirectly induces the production of plant volatiles effective against herbivores	Produced not only in response to herbivory but also to mechanical wounding of plant tissues of chewing herbivores

CROSS-TALK AMONG PLANT HORMONES

✓JA and SA pathway are known to act synergistically during defensive reaction against herbivory
✓JA is produced during attack by chewing insects while SA is converted via methylation to MetSA volatiles which serve as attractants for natural enemies
✓Ethylene modulates the JA-mediated defensive reaction and supresses SA activity

CONCLUSION

✓Investigation on insect-plant co-evolution could open up new challenges to determine the specificity of interaction involving other unexplored signaling molecules encompassing insect and herbivores.
✓Such chemicals and pathways could prove helpful for other functions including plant physiology.
✓It could also open up newer avenue for research on pest management
✓Further availability of advanced technologies could accelerate global systematic and integrated research on plant defenses thereby enriching our understanding on plant-insect herbivore-predator tri-phasic interaction.

PLANT VOLATILES AS PART OF DEFENSIVE REACTION

Terpenes and Terpenoids are known to attract natural enemies of herbivores in various systems Although produced in minute quantities, **nitrogenous volatiles** are quite efficient in attracting carnivorous predators
-**Glucosinolates** (secondary metabolites) are the major intermediate in biosynthesis of nitrogenous volatiles in crucifers
-**Amino acid derivatives** catalyzed by cytochrome P-450 are also are major source for production of nitrogenous volatiles in Cucumber, Gerbera and Lima-beans
Indole volatiles are also effective in attracting the natural enemies of herbivores by specifically affecting specific species. However the role of indole volatiles in modulating the release of other volatiles is quite interesting.
Green leaf volatiles are produced in response to herbivore damage of leaf tissues.
TIMING OF PRODUCTION OF VOLATILES: Green-leaf volatiles are released immediately within minutes of herbivore damage. Emission of indoles start 45 mins later and continues upto 180 mins of herbivory. Terpenoids are produced after 180 mins. of herbivory.

Figure: Representative structure of some plant volatiles (Dudareva *et al* 2006)

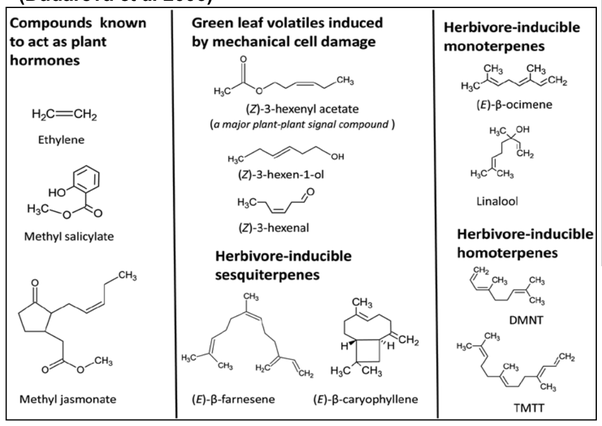


Figure: Salicylic Acid Signaling Pathway (Janda & Ruelland 2014)

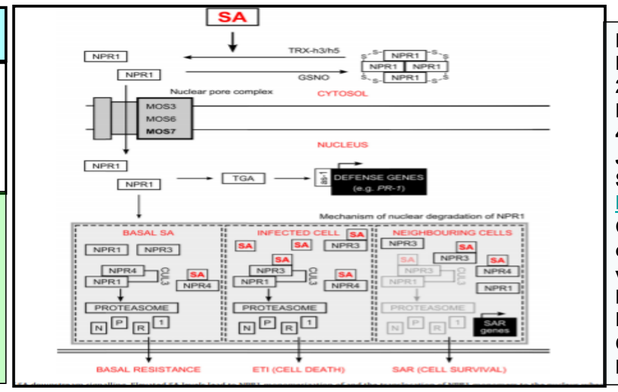
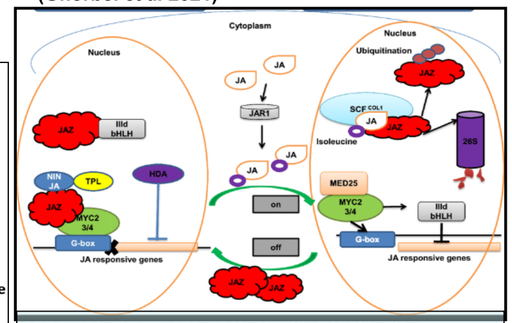


Figure: Jasmonic Acid Signaling Pathway (Ghorbel *et al* 2021)



NATURAL ENEMIES OF INSECT HERBIVORES

24 species of predators belonging to various families (Chrysopidae, Miridae, Geocoridae, Anthocoridae, Syrphidae, Empididae and Coccinellidae) are attracted to plants subjected to herbivory.
34 species of parasitic wasps are attracted towards volatiles emitted during herbivory by hymenopteran, lepidopteron and dipterans.

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