



Plant Trichomes: Their Role as Natural Barriers against Stresses

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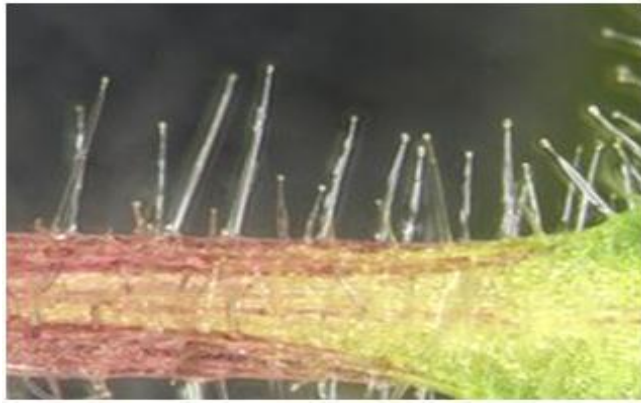
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Trichomes are hair like unicellular or multicellular appendages that are extensions of the above-ground epidermal cells in plants which are distributed universally in all plants species of plant kingdom. Trichomes occur on various plants parts on leaves, stems, petals, sepals, petioles peduncles flowers, seeds and immature fruit. Broadly, trichomes can be classified into glandular (presence of glandular head) and non-glandular (absence of glandular head). Glandular trichomes are usually composed of three parts base cells, stalk cells and one or a few secretory cells at the tip of the stalk. Glandular trichomes may be unicellular or multicellular, trichomes of Cucumber (*Cucumis sativa*), Tobacco (*Nicotiana tobaccum*) and tomato (*Solanum lycopersicum*) are multicellular. Glandular trichomes are further divided into secretory glandular trichomes and non-secretory glandular trichomes according to function. Glandular trichomes produce and release substances like oils, resins, or toxins that protect the plant from pests, diseases, and environmental stress. Non-glandular trichomes, on the other hand, do not release any substances. Instead, they act as physical barriers, deterring herbivores and reducing water loss. Non glandular trichomes are unicellular (*Gossypium hirsutum* and *Arbidopsisthalina*), either branched or with two to five branches (*Artemisisannuain*). Members of Solanaceae and Solanum genus exhibits tremendous variation and diversity of trichomes and are widely studied (Sakshi and Rupesh 2021). For instance, in tomato eight different types of trichomes are categorized from Type I to Type VIII, of which Type I, IV, VI and VII are glandular trichomes, and Type II, III, V and VIII are non-glandular trichomes.

Role of trichomes in Biotic and Abiotic stresses

Trichomes being present in the outermost boundary between plants and environment are considered to be the first line of defense. The defense mechanism of trichomes is attributed to an excellent combination of suitable structural traits and chemical reinforcement in the form of secondary metabolites. The non-glandular trichomes do not possess a secretory mechanism but accumulate large quantities of secondary metabolites such as phenolics which play a wide and important role in protection and regulation against abiotic and biotic stresses. The non glandular trichomes function as a physical barrier against many agricultural pests like leaf hoppers and aphids for example, non-glandular trichomes in the *Solanum* species are mostly spike-like structures that deter herbivores primarily by deterring herbivore movement, feeding and oviposition (Weigendet *al.* 2018; Kariyatet *al.* 2019). Non-glandular hooked trichomes in *Phaseolous vulgaris* confer resistance to *L. trifoli* adults by physically trapping mouth parts, legs and ovipositor where, the entrapments depend on trichome developmental stage and density. Non glandular trichomes can serve as a barrier to infection by foliar pathogens for example, *Phytophthora infestans* (causal agent of late blight) infection in *S. tuberosum*. The presence of trichomes increases the thickness of epidermis and the content of long chain fatty acids which is helpful in reducing evaporation, and heat load, increasing

tolerance to freezing, moderation of leaf temperature or water loss through increased light reflectance, facilitating water absorption and protecting the plant against abiotic stresses.



Trichomes on the petiole of a *Capsicum pubescens* plant



Flower bud of a *Solanum quitoense* leaf

Source: Wikipedia

Glandular trichomes act as chemical barriers by secreting large quantities of secondary metabolites such as terpenes, phenol propanoids derivatives, methyl ketones and defensive proteins (Shepherd *et al.*2005) which are stored in them. These secondary metabolite compounds provide a distinctive smell to plants and acts as a natural barrier to protect plants against herbivorous insects and pathogens. Terpenes provide indirect defense by attracting predators or parasitoids and plays a crucial role in pest management. For instance, glandular trichomes in Solanaceous species produce sesquiterpenes which act as repellent against white fly. The rupturing of glandular trichomes traps insects in *Lycopersicon* species producing acyl sugars and polyphenols where trapped insects die due to starvation or poisoning or out of suffocation. On infestation by aphids, tobacco trichomes release sugar esters to trap and prevent further movement of the pest. Similarly in tomatoes glandular trichomes release sugar esters and prevent infestation of white flies, fruit borer, armyworms, other arthropods like leaf miner, beet armyworm and spider mites. Several studies on *G. arboretum* cottons revealed that flavonoids derived from the phenylpropanoid gave resistance to tobacco bud worm (*Heliothis virescens*). In addition to secondary metabolites, trichomes produce significant defense proteins like phytoalexins, protein inhibitors, polyphenol oxidases on leaf surfaces of tobacco showing pathogen resistance to oomycete pathogen *Peronospora hyoscyamif.sp. tabacina*. Different forms of polyphenol oxidases produced on different types of trichomes in tomato are reported to reduce growth rate of fruit worm.

Trichomes play an important role in water usage by helping to maintain the leaf water content. Dense trichome layers reduce water loss by influencing the leaf's boundary layer, which increases resistance to vapor diffusion, or by regulating energy balance and controlling leaf temperature. The secondary metabolites produced by trichomes create a thick layer on the leaf surface that protects against biotic stresses and reduces transpiration. Trichomes also affect the interaction between water and the leaf surface, contributing to water uptake and overall plant water balance.

Conclusion

Trichomes are versatile structures that play a vital role in a plant's survival and success. From protecting plants against herbivores and diseases to assisting in chemical defense and water retention, trichomes have evolved in diverse ways to meet the challenges of their environments.

References

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