Topic: **AUXIN: DEVELOPMENTAL EFFECTS**

Subject: Botany

M.Sc. (Semester II), Department of Botany
Course: MBOTCC- 7: Physiology and Biochemistry; Unit – III

Dr. Saumya Srivastava
Assistant Professor,
P.G. Department of Botany,
Patna University,
Patna- 800005

Email id: sonata906@gmail.com

Auxins are characterized primarily by their ability to stimulate cell elongation in excised stem and coleoptiles sections, but they are also involved in a host of other developmental responses, including secondary root initiation, vascular differentiation, and the development of axillary buds, flowers, and fruits. In fact, auxin is involved in virtually every stage of plant growth and development from the organization of the early embryo to flowering and fruit development.

Developmental effects include-

[I] **Apical Dominance**

Apical dominance is the phenomenon whereby the main, central stem of the plant is dominant over (i.e., grows more strongly than) other side stems; on a branch the main stem of the branch is further dominant over its own side branchlets. Apical dominance occurs when the shoot apex inhibits the growth of lateral buds so that the plant may grow vertically. Apparently the apical bud is able to exert a dominant influence that suppresses cell division and enlargement in the axillary bud. For this reason, the phenomenon of coordinated bud development is known as apical dominance.

Shortly after auxin was first discovered, Thimann and Skoog questioned whether there might be a relationship between the capacity of the shoot tip to release auxin and its capacity to suppress axillary bud development—in other words, is apical dominance controlled by auxin? They tested this idea by decapitating broad bean (*Vicia faba*) plants and applying auxin to the cut stump. Axillary bud development remained suppressed in the presence of auxin. Since this initial demonstration, the capacity of auxin to substitute for the shoot tip in maintaining apical dominance has been confirmed repeatedly and is now believed that the outgrowth of the axillary bud is inhibited by auxin that is transported basipetally from the apical bud. In support of this idea, a ring of the auxin transport inhibitor TIBA in lanolin paste (as a carrier) placed below the shoot apex released the axillary buds from inhibition.

[II] **Vascular Differentiation**

The ability of an apical bud to stimulate vascular differentiation can be demonstrated in tissue culture. When the apical bud is grafted onto a clump of undifferentiated cells, or *callus*, xylem and phloem differentiate beneath the graft. The relative amounts of xylem and phloem formed are regulated by the auxin concentration: High auxin concentrations induce the differentiation of xylem and phloem, but only phloem differentiates at low auxin concentrations. The regeneration of vascular tissue following wounding is also controlled by auxin produced by the young leaf directly above the wound site. Removal of the leaf prevents the regeneration of vascular tissue, and applied auxin can substitute for the leaf in stimulating regeneration. Vascular differentiation is polar and occurs from leaves to roots. In woody perennials, auxin produced by growing buds in the spring stimulates activation of the cambium in a basipetal direction. The new round of secondary growth begins at the smallest twigs and progresses downward toward the root tip.

[III] **Formation of lateral and adventitious roots**

Although elongation of the primary root is inhibited by auxin concentrations greater than 10^{-8} *M*, initiation of lateral (branch) roots and adventitious roots is stimulated by high auxin levels. Lateral roots are commonly found above the elongation and root hair zone and originate from small groups of cells in the pericycle. Auxin stimulates these pericycle cells to divide. The dividing cells gradually form into a root apex, and the lateral root grows through the root cortex and epidermis.

[IV] **Delays inception of leaf abscission**

The shedding of leaves, flowers, and fruits from the living plant is known as abscission. These parts abscise in a region called the abscission zone, which is located near the base of the petiole of leaves. In most plants, leaf abscission is preceded by the differentiation of a distinct layer of cells, the abscission layer, within the abscission zone. During leaf senescence, the walls of the cells in the abscission layer are digested, which causes them to become soft and weak. The leaf eventually breaks off at the abscission layer as a result of stress on the weakened cell walls.

Auxin levels are high in young leaves, progressively decrease in maturing leaves, and are relatively low in senescing leaves when the abscission process begins. The role of auxin in leaf abscission can be readily demonstrated by excision of the blade from a mature leaf, leaving the petiole intact on the stem. Whereas removal of the leaf blade accelerates the formation of the abscission layer in the petiole, application of IAA to the cut surface of the petiole prevents the formation of the abscission layer. Ethylene also plays a crucial role as a positive regulator of abscission.

[V] **Regulation of floral bud development**

[VI] **Fruit development**

After fertilization, fruit growth may depend on auxin produced in developing seeds. The endosperm may contribute auxin during the initial stage of fruit growth, and the developing embryo may take over as the main auxin source during the later stages.

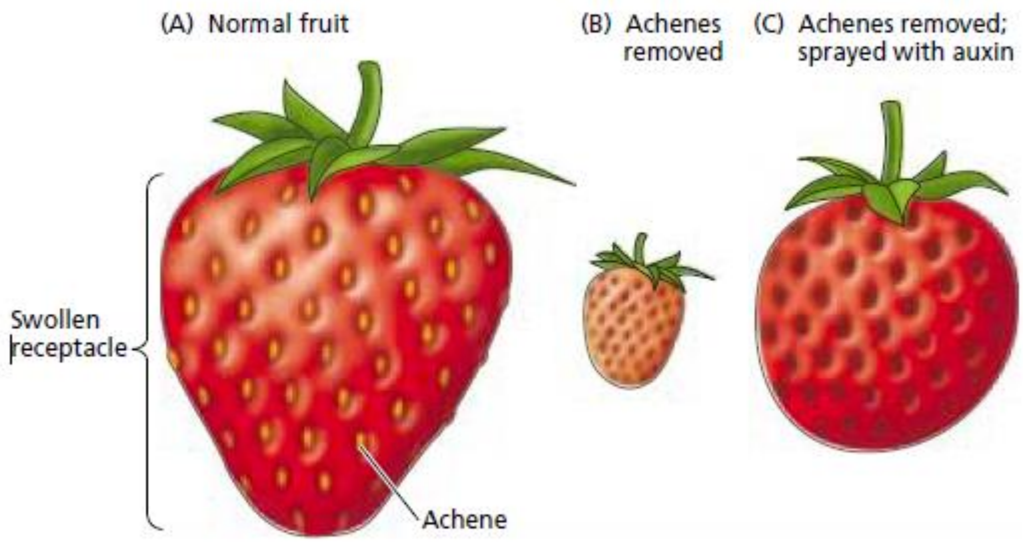

Fig.1. (A) The strawberry "fruit" is actually a swollen receptacle whose growth is regulated by auxin produced by the "seeds," which are actually achenes− the true fruits. (B) When the achenes are removed, the receptacle fails to develop normally. (C) Spraying the achene-less receptacle with IAA restores normal growth and development. (After A. Galston 1994.)[1]

[1] Taiz and Zeiger (2002)

Commercial uses

Auxins have been used commercially in agriculture and horticulture for more than 50 years. The early commercial uses included prevention of fruit and leaf drop, promotion of flowering in pineapple, induction of parthenocarpic fruit, thinning of fruit, and rooting of cuttings for plant propagation. In addition to these applications, today auxins are widely used as herbicides. The chemicals 2,4-D and dicamba are probably the most widely used synthetic auxins.

Selected References

Hopkins, W.G. and Huner, Norman P.A. (2009). *Introduction to plant physiology*. 4th edition. John Wiley & Sons, Inc. (ISBN 978-0-470-24766-2)

Taiz, L. and Zeiger, E. (2002). *Plant physiology*. 3rd edition. Sinauer Associates. (ISBN: 0878938230)

Bartel, B. (1997). *Auxin Biosynthesis*. Annu Rev Plant Physiol Plant Mol Biol.48:51–66.

Bonner, J. and Bandurski, R.S. (1952). *Studies of the Physiology, Pharmacology, and Biochemistry of the Auxins*. Annual Review of Plant Physiology. 3:59–86.

Friml, J., Vieten, A., Sauer, M., Weijers, D., Schwarz, H., et al. (2003). *Efflux-dependent auxin gradients establish the apical-basal axis of Arabidopsis*. Nature. 426:147–53.

Zhao, Y. (2010). *Auxin biosynthesis and its role in plant development*. Annu Rev Plant Biol. 2 (61): 49–64.

Wright, A.D., Sampson, M.B., Neuffer, M.G., Michalczuk, L.P., Slovin, J., and Cohen, J. (1991). *Indole-3-acetic acid biosynthesis in the mutant maize orange pericarp, a tryptophan auxotroph*. Science. 254: 998–1000.

Salisbury, F.B. and Ross, C.W., 1934- (1985). *Plant physiology*. 3rd edition. Belmont, Calif Wadsworth Pub. Co.