

PLANT GROWTH REGULATORS

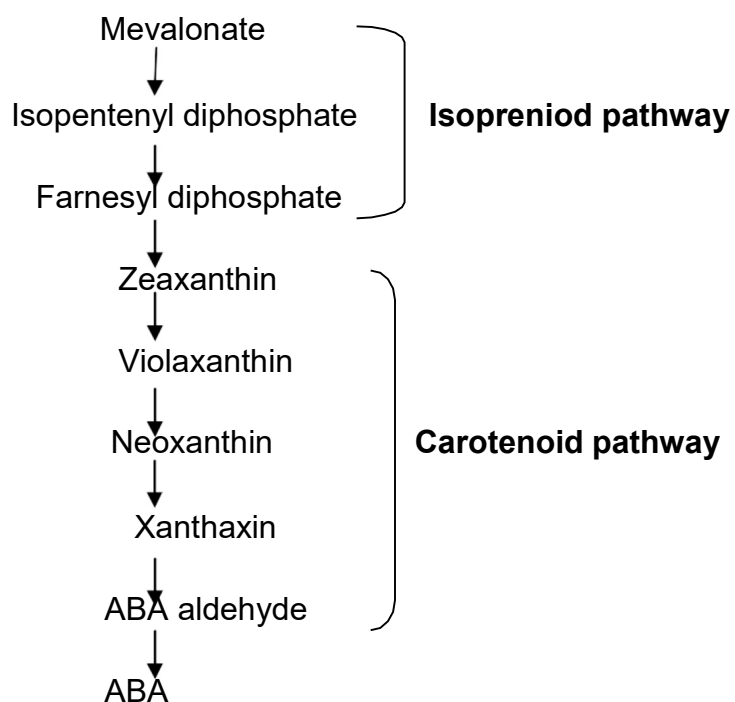
ABSCISIC ACID (STRESS HORMONE)

27.1 Occurrence: the plant growth regulator ABA is one of the wide spread and naturally occurring inhibitor found in plants. Addicot and his colleagues (1964) isolated this abscission causing compound from cotton bolls and named it as abscisin I & abscisin II. It is now known that ethylene is the hormone that triggers abscission and that ABA induced abscission of cotton bolls is due to ABA's ability to stimulate ethylene production. In higher plants ABA occurs in all parts of the plant body. It has been reported from the leaves of birch (*Betula sps*) and tubers of potato. ABA is found in all parts of the seed namely the seed coat, embryonic axis, cotyledons and endosperm.

27.2 Biosynthesis:

It is a sesquiterpenoid (15-carbon) which is partially produced via the mevalonic pathway in chloroplasts and other plastids.

ABA is synthesis in plants involves two pathways (1) carotenoid pathway (2) Mevalonic acid pathway or Isoprenoid pathway.



Site of synthesis

All parts of the plants such as stem, root and leaves. Fruits and seeds are also capable of ABA synthesis.

Transport

ABA is transported by both the xylem and phloem, but it is normally much more abundant in the phloem sap.

27.3 Mode of action

ABA is involved in the short term physiological effects (e.g. stomatal closure), as well as long term developmental processes (e.g. seed maturation). Rapid physiological responses of ABA frequently involve alteration in the fluxes of ions across membranes and may involve some gene regulation as well.

Mode of action of ABA in causing various physiological effects can be seen in three different ways

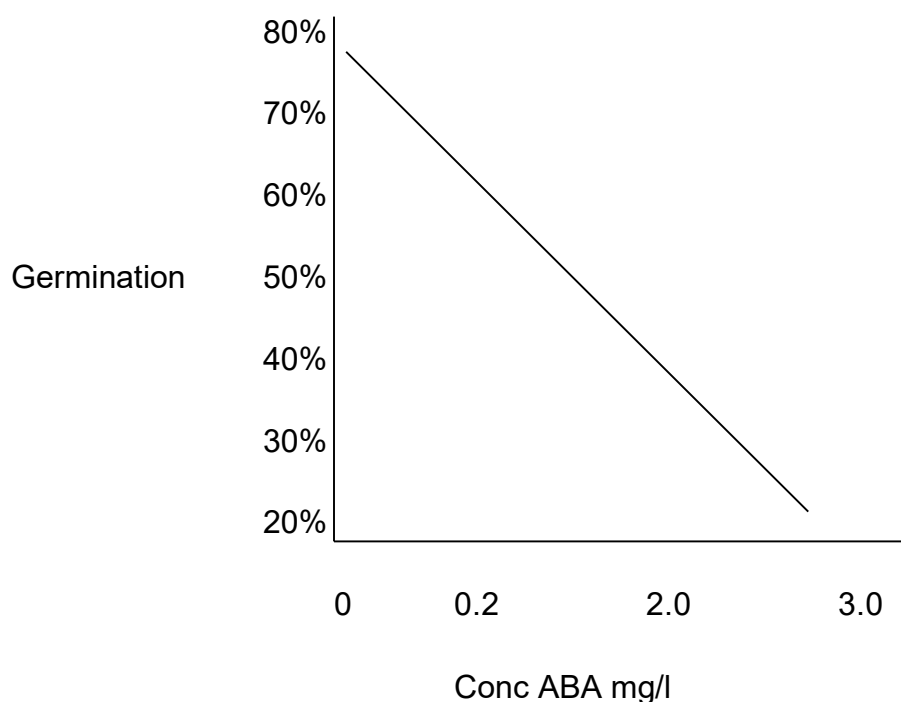
- 1) ABA brings about changes in membrane permeability for different ions (Like K^+ , Ca^{++} etc.) . It plays a role in stomatal closure.
- 2) ABA inhibits DNA & RNA synthesis (transcription) finally leads to senescence.
- 3) It inhibits translation (Protein synthesis) thus formation of enzymes is blocked.

Germination process is affected ultimately leads to dormancy.

27.4 PHYSIOLOGICAL ROLE

A) Seed dormancy:

Application of ABA inhibits seed germination in several species.



Similarly seeds which are dormant are shown to contain ABA.

Seeds of apple remain dormant and fail to germinate till they are exposed to a period of stratification. such seed show the presence of ABA. When the seeds are stratified the ABA content falls with a corresponding increase in GA content. Thus, it can be concluded that the seed dormancy is controlled by GA-ABA balance at least in some species.

ABA helps in inhibiting precocious germination and vivipary. This is very important because dormancy caused by ABA do not allow the seed to germinate while it is still on its mother plant.

B. Bud dormancy

In woody species, dormancy is an important adoptive feature in cold climates. When a tree is exposed to very low temperatures in winter it protects its meristems with bud scales and temporarily stops bud growth. Bud dormancy in Acer, betula and other temperate tree sps. This is accompanied by build up of ABA within these plants.

C. Effect of stomata

Application of ABA causes rapid closure of stomata. The stomatal aperture progressively decreases with the concentration of ABA.

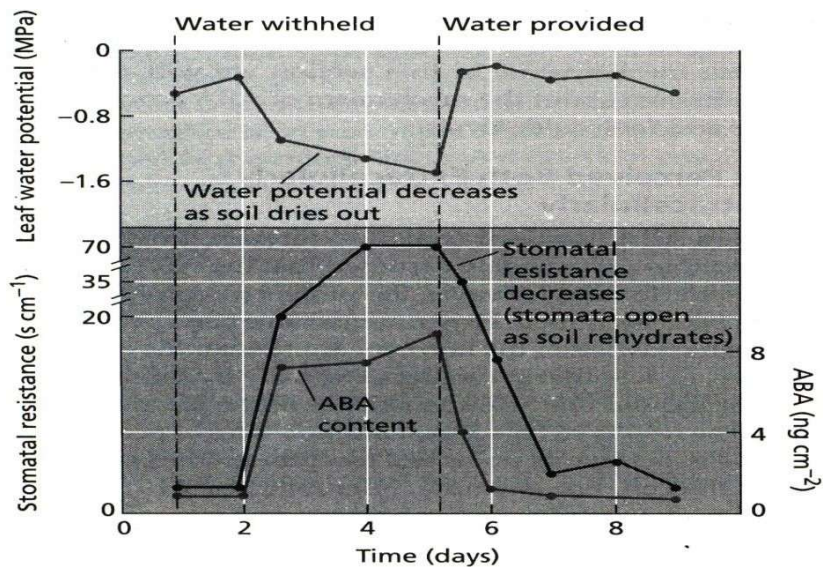


FIGURE Changes in water potential, stomatal resistance (the inverse of stomatal conductance), and ABA content in maize in response to water stress. As the soil dried out, the water potential of the leaf decreased, and the ABA content and stomatal resistance increased. The process was reversed by rewatering. (After Beardsell and Cohen 1975.)

*FIGURE IS FROM REFERENCE 6

ABA accumulates in higher concentration in wilting leaves. This accumulated ABA closes stomata. ABA might inhibit the formation of enzymes which are responsible for the conversion of starch into sugar and formation of organic acids. It reduces the osmotic concentration and causes closure of stomata.

D. Senescence

ABA is quite effective in promoting senescence of excised leaf disks of both monocots and dicots. Although leaf disks are affected, when sprayed on the corresponding intact leaf, ABA is not effective even at higher doses in inducing senescence.

E. Flower initiation

ABA induces flowering in SD plants and inhibits the same in LD plants. Here the hormone inhibits vegetative growth and causes apical bud dormancy. In such plants onset of dormancy precedes flowering. Therefore, effect of ABA on flowering is indirect.

F. Antagonism

ABA inhibits GA stimulated growth in various forms. Therefore ABA is known as Antigibberellin.
