

Topic: Growth hormones; Gibberellins

B.Sc. Botany (Sub.) II

Group: C

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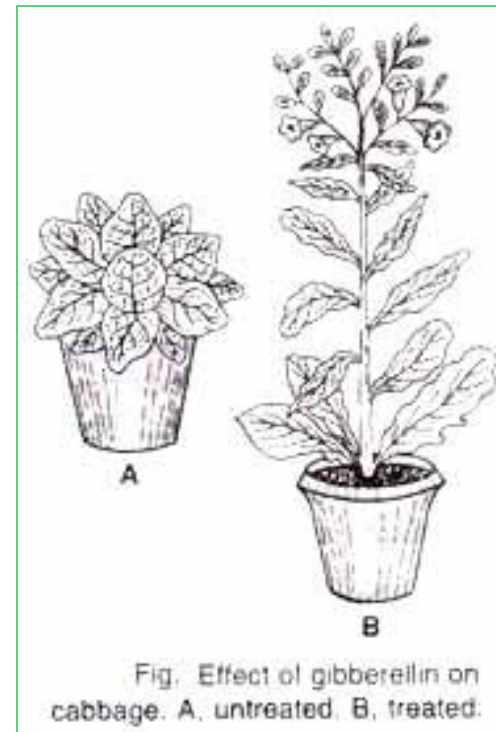
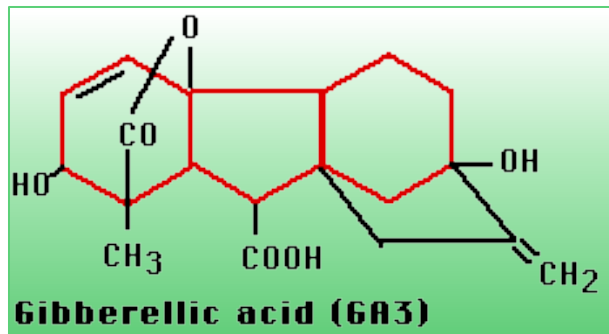
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The effect of gibberellins had been known in Japan since early 1800 where certain rice plants were found to suffer from bakane or bakanae (foolish seedling) disease. Such rice plants were thin, pale green; spindle shaped, longer by 50% than the healthy plants, and were sterile.

The disease was found by Hori (1918) and Kurosawa (1926) to be caused by a fungus, *Gibberella fujikori*. The fungus is the perfect stage of *Fusarium moniliforme*.

Kurosawa also found that the sterile filtrate of the fungus also caused appearance of disease symptoms in uninfected rice seedlings. The active substance was separated and named gibberellin by Yabuta (1935). Yabuta (1938) also prepared crystalline form of gibberellin (it actually consisted of six gibberellins).

Japanese work came to light only after World War II. Gibberellic acid or GA₃ was isolated in pure form by Brian et al in 1955. Cross (1961) worked out the structure of gibberellic acid, GA₃.



It is chemically $C_{19}H_{22}O_6$. GA_3 is one of the most intensively studied gibberellin. A mixture of GA_4 and GA_7 is used commercially. Until now 125 different gibberellins have been identified. Many of them occur naturally in plants and fungi. *Gibberella fujikori* has as many as 15 gibberellins.

A single plant also possesses a number of gibberellins. This is in contrast to auxin, where a single natural hormone occurs. Gibberellins are synthesised in the apical shoot buds (young leaves), root tips and developing seeds. The precursors for their synthesis is mevalonic acid (derived from acetyl coenzyme A). Gibberellin transport occurs through simple diffusion as well as through conducting channels.

Bioassay of Gibberellins-

1. Dwarf Pea

Seeds of dwarf pea are allowed to germinate till the formation of coleoptile. GA solution is applied to some seedlings. Others are kept as control. After 5 days, epicotyl length is measured. GA stimulates epicotyl growth with a concentration as low as 1 Nano gram.

2. Barley Endosperm

Endosperms are detached from embryos, sterilized and allowed to remain in 1 ml of test solution for 1-2 days. There is a build-up of reducing sugars. The content of reducing sugar is proportional to gibberellin concentration. Reducing sugars are not formed in control experiment where endosperms are kept in plain water.

Functions:

Stem and Leaf Growth

Gibberellins help in cell growth of stem, leaves and other aerial parts. Therefore, they increase the size of stem, leaves, flowers and fruits. Gibberellins, however, do not seem to play any such part in case of roots.

Dwarf Shoots

Besides general increase in stem length, gibberellins specifically induce intermodal growth in some genetically dwarf varieties of plants like Pea and Maize. It appears that dwarfness of such varieties is due to internal deficiency of gibberellins.

Bolting

Gibberellins induce sub-apical meristem to develop faster. This causes elongation of reduced stem or bolting in case of rosette plants e.g., Henbane, Cabbage and root crops e.g., Radish. A weekly doze of 0.1 mg gibberellic acid made cabbage plants to grow taller than 3.5 m. Normally bolting occurs at the onset of reproductive phase. It is favoured in nature by either cold nights or long days.

Dormancy

Gibberellins overcome the natural dormancy of buds, tubers, seeds, etc. and allow them to grow. In this function they are antagonistic to abscisic acid (ABA).

Seed Germination

During seed germination, especially of cereals, gibberellins stimulate the production of some messenger RNAs and then hydrolytic enzymes like amylases, lipases ribonucleases and proteases. The enzymes solubilize the reserve food of the seed. The same is transferred to embryo axis for its growth.

Fruit Development

Along with auxin, gibberellins control fruit growth and development. They can induce parthenocarpy or development of seedless fruits from unfertilized pistils, especially in case of pomes e.g., Apple, Pear.

Flowering

They promote flowering in long day plants during non-inductive periods.

Vernalization

Vernalization or low temperature requirement of some plants can be replaced by gibberellins.

Sex Expression

Gibberellins promote the formation of male flowers on genetically female plants of Cannabis. They can also replace female flowers with male flowers on monoecious plants of cucurbits.

Curvatures

In Sunflower, phototropic and geotropic responses of shoot tips are due to redistribution of gibberellins.

Uses of Gibberellins:

Fruit Growth

Application of gibberellins increases the number and size of several fruits, e.g., Grape, Tomato. The hormone creates more room by increasing the size of stalks so that fruits can grow in size. Size and shape of Apple fruits is enhanced by application of GA_4 and GA_7 mixture.

Parthenocarpy

Seedless pomaceous fruits can be produced by application of gibberellins to unpollinated flowers.

Malt

Gibberellins (e.g., GA_3) increase the yield of malt from barley grains.

Overcoming Dormancy

Gibberellins can be employed for breaking seed and bud dormancy. They induce germination of positively photoblastic seeds of Tobacco and Lettuce in complete darkness.

Delayed Ripening

GA₇ delays senescence so that fruit can be left on the tree for longer period. It extends period of marketing. Ripening of Citrus fruits can be delayed with the help of gibberellins. This is useful in storing the fruits.

Flowering

Gibberellins can be used in inducing off season flowering in many long day plants as well as plants requiring vernalization.

Sugarcane- Spraying of sugarcane crop with gibberellins increases length of stem and yield of sugarcane to as much as 20 tonnes/acre.

Early Maturity- Juvenile conifers sprayed with mixture of GA₄ and GA₇ reach maturity quite early resulting in early seed production.