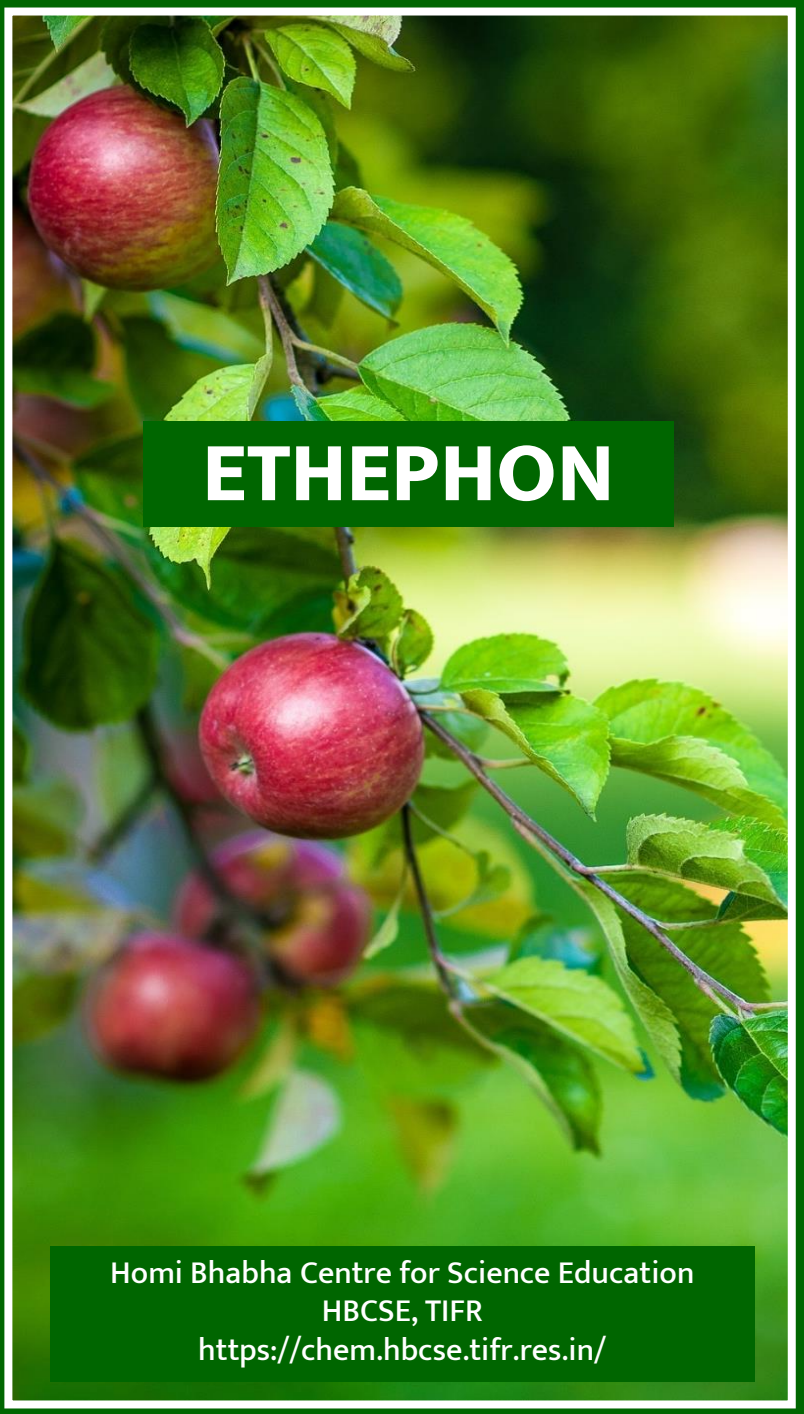
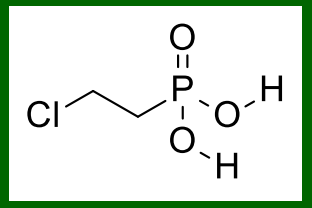


ETHEPHON

Homi Bhabha Centre for Science Education
HBCSE, TIFR
https://chem.hbcse.tifr.res.in/

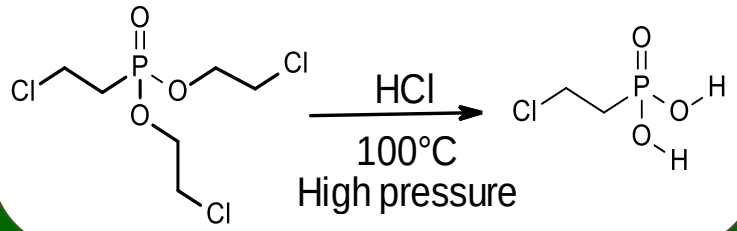
Molar mass: 144.49 g mol^{-1}
Melting point: 65 °C – 74 °C



Ethephon is an organophosphorus compound which gained commercial importance after 1965, when it was found to promote growth in plants. It was registered as a pesticide in the United States in 1973 by Union Carbide Limited. However, its prominent use has been as a plant growth regulator.
It is a white crystalline solid, but commercially is available largely as aqueous formulations, such as *Etheverse ®, Cerone ®, and Ethrel ®*. The formulations are designed for specific uses. For example, Cerone® is mostly used on barley and wheat in the US.

Synthesis

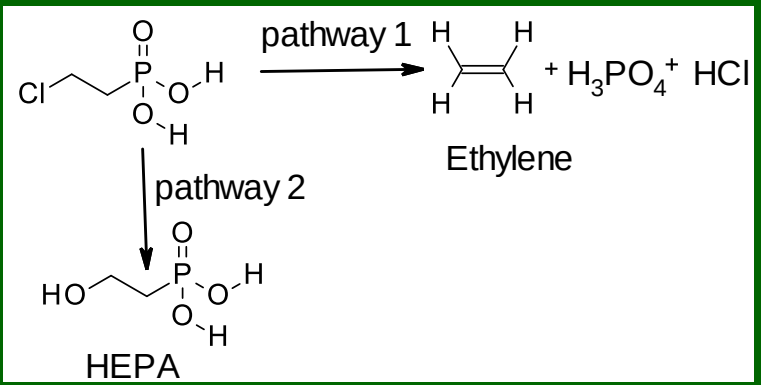
Production of ethephon in the industry utilizes the hydrolysis reaction of bis-(2-chloroethyl)-2-chloroethylphosphonate with aqueous hydrochloric acid at a temperature of about 100° C at elevated pressure.



Chemical properties

Ethephon solutions are acidic with pH range 1 - 2.
For farms, ethephon solutions should be prepared in mild aqueous alkaline solution (i.e. dilute solutions of sodium or calcium carbonate) to attain pH close to 7. However, in reality, many farmers still spray by diluting ethephon solution with water.

At pH > 5, ethephon undergoes decomposition by two pathways simultaneously. One pathway gives ethylene which induces various physiological changes in plants. The second pathway leads to the formation of 2-hydroxyethylphosphonic acid (HEPA) which is toxic to the liver of animals. The rate of decomposition depends on pH and concentration of ethephon solutions.



Due to above reactions, ethephon is toxic to skin and corrosive to many materials.

Corrosive Toxic

Pre-harvest uses

Ethylene is a major (and the first identified) plant hormone that affects several stages of plant growth. It is produced naturally in all essential parts in plants, such as leaves, fruits, flowers, and roots, from amino acid methionine.

Thus, as a source of ethylene, ethephon is used for numerous pre-harvest applications in different crops, such as-

❖ increasing fruit pigmentation and maturity in apples, black berries, tomatoes and grapes.

❖ yield improvement in cereals (wheat, barley, rye and rice) by preventing bending over of stems near ground level which makes harvesting difficult.

❖ a herbicide for *Ipomoea cairica* plant. The mode of action is by production of excess ethylene which causes increase in electrolyte leakage and decrease in chlorophyll content, leading to plant death.

Post-harvest uses

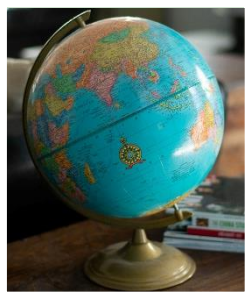
Ethephon is applied to fruits such as mangoes and bananas to promote ripening, just before sale in retail markets.

Direct contact of ethephon with fruits should be strictly avoided. Residues of phosphoric acid and HEPA formed from ethephon decomposition remaining on fruit adversely affect health of consumers.
Correct way of using ethephon is to keep an ethephon sachet or solution in a container in the storage rooms/boxes such that only released ethylene comes in contact with the fruits.

Compared to acetylene (produced from CaC_2), ethylene ripens the fruits much faster. Hence, use of ethephon is increasing much more than that of calcium carbide.

Global ethephon market

Ethephon formulations are registered in more than 60 countries. Its global market has gained importance in the agriculture sector in past decades due to increasing demand for pre- and post-harvest uses.



Asia Pacific is expected to retain the dominant share in the global ethephon market in the coming years, with high production in China.

Other main producers of ethephon in Asia Pacific are India, South Korea, Japan, Malaysia, and Australia

References and Further Reading

1. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-099801_1-Apr-95.pdf
2. Walters, K. J., & Lopez, R. G. (2018). Ethephon Foliar Sprays Are Influenced by Carrier Water Alkalinity and Ambient Air Temperature at Application. HortScience, 53(12), 1835–1841. doi: 10.21273/hortsci13426-18
3. Transparency Market Research. (n.d.). Ethephon Market Segment Forecasts up to 2020, Research Reports. Retrieved on July 7, 2020 from https://www.transparencymarketresearch.com/ethephon-market.html

Now, can you find?

1. Which companies are the leading producers of ethephon in the global market?
2. Which formulation of ethephon is used in your local fruit market/agricultural supply shop?
3. What substances can be used to reduce toxicity of residues left on a fruit or a material?

For more questions, refer Indian National Chemistry Olympiad (INChO) 2020 exam, on https://olympiads.hbcse.tifr.res.in/ (problem 3)