Reprinted from 'Dyes, Chemicals & Plastics Review,' Annual Number 1973

ETHREL—a chemical "genie" in the field of horticulture

by **Dr. B. S. SHETTY**
Technical Adviser, Agromore Limited, Bangalore

THE discovery of auxin activity of Indole Acetic Acid led chemists to prepare a wide range of substances of similar structure and from this work there emerged many synthetic auxins which possessed higher physiological activity than the growth hormone itself. As is well known, the widespread use of synthetic auxins such as 2,4-D for controlling weeds in cereal and other crops has had a tremendous impact on food production. The rooting of cuttings, prevention of preharvest drop of fruit and the promoting of fruit-setting in the absence of pollination are examples of other important uses of auxins in agriculture.

TELL-TALE ETHYLENE

One other compound which must be considered as a growth hormone is the simple, unsaturated, gaseous hydrocarbon, ethylene, C_2H_4. Ethylene, a "broad spectrum" physiological agent in plant metabolism, has excited new interest in recent years following accumulation of evidence which places it in the category of a plant hormone. Every plant tissue produces ethylene and is influenced by ethylene at some stage in its life cycle; yet the origin of ethylene in plants and the pathways of its biosynthesis are for most part still to be discovered.

Much work has been carried out on the mode of action of ethylene, the specific effects of which must be related to its unsaturated character and its small molecular size, since higher olefines are much less active and corresponding paraffin, ethane, is inactive. Depending upon the stage of plant development ethylene may inhibit cell division and elongation; promote radial cell expansion and extend the growth period; promote flowering and modify sex expression; promote leaf and fruit abscission; and promote fruit ripening in addition to a myriad other effects.

THE QUEST FOR THE WONDER COMPOUND

The widespread interest in the biosynthesis and mode of action of ethylene has naturally led to the discovery of ethylene-generating chemical, 'ethephon' also variously cited as Amchem 66-329, CEPA, 2-chloroethyl phosphonic acid or "Ethrel" in the last decade of sixties.

When this compound "Ethrel" disintegrates, it releases ethylene and also chloride and phosphate ions. "Ethrel" is basically stable in

aqueous solutions below pH_4. When the presence of hydroxyl ions is increased (This could be done in the laboratory by adding sodium hydroxide to raise the pH) and the pH rises above 4, disintegration of chemical takes place. The pH of the cytoplasm of plant cell is generally greater than 4, so the plant growth activity of 'ethephon' has been attributed primarily to its ability to release ethylene to plant tissues. "Ethrel" formulations provide a convenient way to apply ethylene without the need of gas-confining chambers. With this compound, the application of exogenous ethylene, supplementing that produced by the plant has been found to exert dramatic morphological and physiological effects.

A GENTLE TOUCH ON FLOWERING AND GROWTH

In mango, "Ethrel" has been used successfully to break the habit of biennial bearing—a phenomenon whereby the tree flowers in alternate years. 'Ethephon' at 200 ppm sprayed 5 times at a fortnightly interval induced flowering during off-season—which means one can have a uniformly regulated crop every year. Besides, it has been found to induce earlier and more abundant flowering.

Flower induction is an essential part of production techniques in most areas where pineapples are grown. With high percentage of sterility, normally only 40 per cent of the pineapple plants come to flowering. An experiment carried out at Indian Institute of Horticultural Research, Bangalore, revealed that more than 90 per cent of the plants came to flowering when 40 ml of 100 ppm 'ethephon' solution (or 25 ppm 'ethephon' in combination with 2 per cent urea and calcium carbonate) was poured through the collar of each plant. Besides, a single application of 'ethephon' has hastened the ripening in most plants and fruits can be harvested in a single picking.

Fall and spring applications of 250 to 2000 ppm of 'ethephon' to apple and pear trees have suppressed vegetative growth and subsequently promoted flowering. The treatment can promote earlier bearing or control biennial bearing.

Foliar sprays of 'ethephon' retarded the height of onion and when applied to non-bolting plants partially prevented seed stalk emergence and reduced seed yield of early developing inflorescences. Two field applications of 480 ppm concentration starting when 75 per cent of the plants had reduced seed stalk height thus preventing lodging of seed stalk. Treating onions at the 4 to 5 true leaf-stage with 500 to 10,000 ppm at weekly intervals of 3 to 5 weeks initiated bulbs earlier, increased the frequency of bulbing and also accelerated their maturity.

Producing hybrid cucurbit seed is costly when male flowers are removed by hand from seed parents to prevent self-pollination. Single or repeated sprays of 125 to 250 ppm of 'ethephon' during 1st to 5th true leaf-stage can markedly increase earlier formation of female flowers and eliminating male flowers.

'Ethephon' treatment may help overcome seed dormancy, germination of Virginia type of groundnut seeds from apical and basal stem locations soaked for 16 hr. in 'ethephon' concentration of 72 to 145 ppm was 100 per cent compared to 13 and 60 per cent with untreated apical and basal seeds. Breaking the dormancy of other seeds with 'ethephon' has become a routine operation.

Vegetative growth of tree fruits such as apple and pear has been suppressed with 'ethephon' foliar sprays of 250 to 1000 ppm. On vigorous grape vines, reduced vegetation growth after mid-season foliar application of 1000 ppm 'ethephon' should reduce the labour required for pruning and stimulate more uniform cluster maturity as a result of better light penetration.

A MYSTIC KEY TO REGULATE CROP AND HARVEST

Many plant scientists have shown that ethylene will induce or accelerate abscission of leaves and fruit. Regulating defoliation, flower abscission, immature fruit thinning and abscission of mature fruit provides important crop production control and facilitates easy harvesting.

Many cultivars of fruit trees frequently set more fruit than can mature to commercial standards of size and quality. When this condition exists it is desirable to remove the surplus early in the growing season by hand, mechanical, or chemical thinning of blossoms or immature fruit.

Spraying foliage with 250 to 1000 ppm 'ethephon' in late fall, after harvest, has reduced apple-set following spring. Immature pears

have been thinned by fall and post-bloom sprays of 240 to 480 ppm. Observations at harvest have generally shown that the size of fruit from trees adequately thinned with 'ethephon' is comparable to that of hand thinned controls.

Spraying 10 to 1000 ppm 'ethephon' in the pre-bloom and bloom stages shows promise for thinning flowers and fruit in some grape (Vitis vinifera) cultivars. A 1000 ppm treatment in the blossom stage may be useful for eliminating unwanted fruits from young nursery stock and newly planted vine-yards.

Eliminating unwanted blossoms or fruit at certain crop periods can also assure more uniform fruit maturity and thus reduce labour costs of multiple picking and grading for marketing. For example, 400 to 600 ppm 'ethephon' foliar spray treatment of coffee when flower buds were 2 to 3 mm long, abscissed unwanted flowers.

Similar flower removal has been obtained on tomatoes with rates of 100 to 500 ppm. Unpollinated flowers were easier to abscise than those which had achieved anthesis. Early developing staminate or pistillate flowers of cucurbits can be aborted by a 200 to 400 ppm 'ethephon spray.

A MAGIC WAND ON MATURITY AND RIPENING

Triggering or accelerating the ripenning changes with 'ethephon' either before or after harvest suggests the possibility of important agricultural uses such as increasing early yields, programming harvest schedules or to reduce number of hand pickings required, and improving fruit colour or market appearance.

Tomatoes can be ripened earlier with a 250 to 500 ppm 'ethephon' foliar spray applied shortly after pollination.

'Ethephon' foliar sprays of 700 to 1400 ppm can accelerate coffee ripening. Spraying trees with mature green coffee berries 7 to 11 weeks before first major picking hastened the main picking period by 2 to 4 weeks. By application of 'ethephon,' it is possible to induce lateral branching and to get uniformly ripened berries. Earlier maturity should be of use to spread concentrated harvest periods thereby making picking and processing more economical.

Spraying of 'ethephon' 250 to 1200 ppm on chillies and pimiento peppers promoted earlier colouring and significantly increased the recoverable yield of red fruit from a single harvest. Treatments were made when fruits started to turn brown or shortly after the first red fruit picking.

A single dipping procedure with 'ethephon,' not requiring the construction or use of controlled temperature and humidity chambers, would be of interest to horticulturists.

Post-harvest dipping for 30 seconds to 3 minutes or spraying fruit with ethephon has promoted ripening of bananas at 500 to 2000 ppm; pears at 250 to 1000 ppm; melons at 1000 to 4000 ppm; tomatoes at 1000 to 4000 ppm; persimmons at 500 ppm; and mangoes at 100 to 10,000 ppm. The quality of 'ethephon' treated fresh market fruit or processed product has generally been consistently equal to or better than that of untreated fruit.

Green lemons, grape fruits, mosambis and oranges dipped in a 1000 ppm 'ethephon' solution for 3 seconds to 10 minutes have developed beautiful marketable colour 7 to 10 days after treatment.

Persimmon ripening was promoted by a post-harvest dip in 500 ppm 'ethephon' solution. Seven days ater treatment fruit became soft and astringency was removed.

Promotion of "ripening" in sugarcane, a term used to designate the accumulation of sucrose in the cane, appears promising as a result of single or repeat application of 2 to 4 lb/acre of 'ethephon' 2 to 4 weeks before anticipated harvest.

In tobacco, the term "ripening" indicates biochemical and physical changes in the leaf that render it marketable with respect to colour, texture and aroma. Foliar application of 'ethephon' at rates of 1 to 2 lb/acre promoted this process as evidenced by faster uniform flue-cured tobacco leaf yellowing. Properly timed 'ethephon' applications have also inhibited flowering and sucker growth after topping and decreased nicotine content in tobacco stems and leaves.

A BOON TO LATEX PRODUCTION

A new development, said to be rubber industry's biggest breakthrough in research, involves the

use of chemical stimulant 'ethephon.' Stimulating latex production is the first commercial use for 'ethephon.' Experience has shown that stimulants are important for efficient exploitation of most clones at some stage during average 30 years life span of rubber trees.

Brushing a 10 per cent concentration of 'ethephon' from the ready-to-use latex stimulant on a 1½ to 2½ inch strip of bark directly below the tapping cut has increased latex flow and dry rubber yields upto 100 per cent or more on commercially important clones without any deleterious effect on the plant system.

Apart from the spectacular performance of the increased latex stimulation during the normal months, "Ethrel" has been found to increase the latex yield even during the wintering period.

Twice the rubber on an average from the plantations and small holdings which already are cutting costs to a level which makes synthetic rubber sit-up, spells safety for natural rubber.

It has not been possible in this short review to deal with all aspects of "Ethrel." Research on growth regulation and application know-how of "Ethrel" is proceeding on many fronts. Among the growth reactions, the chemical actions of "Ethrel" are legion. Heralded as chemical "genie" the world over, "Ethrel" offers many potentialities to horticulturists as its use is being unravelled more and more from the further studies.