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APOPTOSIS (Programmed Cell Death) DURING PLANTS AND ANIMALS DEVELOPMENT

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Introduction

The term apoptosis first appeared in the literature in 1972 (Kerr *et al*., 1972) and was termed programmed cell death by Lockshin (Lockshin and Beaulaton, 1974). Cells can activate an intracellular death program and kill themselves in a controlled way, a process called programmed cell death (PCD)/apoptosis. In another words, it is an active, genetically controlled process leading to selective elimination of unwanted or damaged cells. Means, it is a fundamental process of life. With the evolution of increasingly complex multicellular organisms, PCD has been adapted to diverse functions in developmental patterning:- cell differentiation, cell homeostasis and immune systems (Hautegem *et al*., 2015). Different PCD types have been distinguished by function, occurrence, and morphological and biochemical features. However, a unifying definition recognizes PCD as any process of genetically encoded, actively controlled cellular suicide, calling for PCD diagnosis based on genetic or at least pharmacological evidence.

Research on animal PCD, most prominently apoptosis, has revealed an intricate molecular network controlling PCD in development and disease. The activation of caspases, a group of ubiquitously expressed cysteine pro-teases, is central to apoptosis control. Caspase activation occurs via a proteolytic cascade, started by initiator caspases that activate executer caspases, which in turn de-grade a plethora of vital proteins. Initiator caspases are activated by the cytosolic apoptosome complex containing apoptotic protease activating factor 1 (Apaf-1) and cytochrome c release from mitochondria. Cytochrome c release in turn is tightly regulated by the antagonistic action of pro- and anti-apoptotic members of the B-cell lymphoma 2 (Bcl-2) family. In addition, regulation by an array of apoptotic inhibitors prevents accidental PCD activation. Next to these forms of post-translational control, transcriptional regulation plays an important role in animal apoptosis, particularly in developmental contexts. Notably, if apoptosis is blocked, independently regulated back-up cell death mechanisms can kick in to execute alternative forms of PCD. In comparison to state-of-the-art studies in animals, plant PCD research is – despite recent advances – still in its infancy. However, the importance of PCD for plant life is uncontested, with a growing number of laboratories from various backgrounds researching plant PCD. PCD is a central component of the plant immune response, with hypersensitive response-induced PCD having received considerable attention. Cell death processes have also been described during abiotic plant stress responses. Many instances of PCD are integral to plant vegetative and

reproductive development. The plant life cycle alternates between multicellular generations comprising the haploid gametophytes and the diploid sporophyte. During gametophyte development, fertilization, and subsequent seed development, developmentally regulated PCD (dPCD) processes are a crucial determinant of the reproductive success of a plant.

Programmed cell death is an active process characterized by:

1. DNA fragmentation 2. Chromatin condensation 3. Fragmentation of the nucleus and cell 4. Shrinkage of cell and formation of apoptotic bodies (Wang *et al*., 1996b)

- Such apoptotic bodies and cell fragments are readily recognized by macrophages and neighbouring cells so cells that die by apoptosis are eventually removed from tissues

Apoptosis depends on an intracellular proteolytic cascade that is mediated by caspases:-

- Caspase (C for cysteine & asp for aspartic acid) is a family of proteases that have a cysteine at their active site and cleave their target proteins at specific aspartic acids
- Each caspase is initially made as an inactive proenzyme (procaspase).
- Procaspase is activated by proteolytic cleavage by a caspase (already activated) and then split into a large & a small subunit that form a heterodimer and two such dimers assembe to form active tetramer.
- Prodomains contain a caspase recruitment domain (CARD) that enables procaspase to assemble with adaptors proteins into activation complexes when the cell receives a signal to undergo apoptosis.
- Now one molecule of active initiator caspase gives rise to many molecules of executioner caspases.
- The executioner caspases then cleave a variety of key proteins in the cell, including specific cytosolic proteins and nuclear lamins hence leading to controlled death of the cell.

Pathways of apoptosis:

1. Cell-surface death receptors activate the extrinsic pathway of apoptosis

Extracellular signal proteins binding to cell-surface death receptors trigger the extrinsic pathway of apoptosis. Death receptors are transmembrane proteins containing an extracellular ligand-binding domain, a single transmembrane domain, and an intracellular death domaln, which is required for the receptors to activate the apoptotic program. The receptors are homotrimers and belong to the tumor necrosis factor (TNF) receptor family, which includes a receptor for TNF itself and the Fas death receptor. The ligands that activate the death receptors are also homotrimers; they are structurally related to one another and belong to the TNF family of signal proteins.

A well-understood example of how death receptors trigger the extrinsic pathway of apoptosis is the activation of Fas on the surface of a target cell by Fas ligand on the surface of a killer cytotoxic lymphocyte. Then activated by the binding of Fas ligand, the death domains on the cltosolic tails of the Fas death receptors recruit intracellular adaptor proteins, which in turn recruit initiator procaspases (procaspase-8, procaspase-7}, or both), forming a death-inducing signaling complex (DISC). Once activated in the DISC, the initiator caspasesa activate downstreame excutioner procaspasest to induce apoptosis. As we discuss later, in some cells the extrinsic pathway must recruit the intrinsic apoptotic pathway to amplify the caspase cascade in order to kill the cell. Many cells produce inhibitory proteins that act either

extracellularly or intracellularly to restrain the extrinsic pathway. For example, some produce cellsurface decoy receptors, which have a ligand-binding domain but not a death domain; because they can bind a death ligand but cannot activate apoptosis, the decoys competitively inhibit the death receptors. Cells can also produce intracellular blocking proteins such as Fl14 which resembles an initiator procaspase but lacks the proteolltic domain; it competes with procaspase-8 and procaspase-10 for binding sites in the DISC and thereby inhibits the activation of these initiator procaspases. Such inhibitory mechanisms help prevent the inappropriate activation of the extrinsic pathway of apoptosis. In some circumstances, death receptors activate other intracellular signalling pathways that do not lead to apoptosis. TNF receptors, for example, can also activate the NFrB pathway, which can promote cell survival and activate genes involved in inflammatory responses.

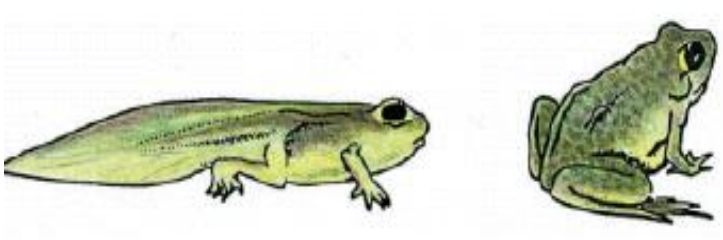
2. The intrinsic pathway of apoptosis depends on mitochondria

Cells can also activate their apoptosis program from inside the cell, usually in response to injury or other stresses, such as DNA damage or lack of oxygen, nutrients, or extracellular survival signals (discussed later). In vertebrate cells, such intracellular activation of the apoptotic death program occurs via the intrinsic pathway of apoptosis, which depends on the release into the cytosol of mitochondrial proteins that normally reside in the intermembrane space of these organelles. Some of the released proteins activate a caspase proteolytic cascade in the cltoplasm, leading to apoptosis. A crucial protein released from mitochondria in the intrinsic pathway is cytochrome c, a water-soluble component of the mitochondrial electron-transport chain. When released into the cytosol, it has an entirely different function: it binds to a procaspase-activating adaptor protein called Apafl (apoptotic protease actiuating factor-l), causing the Apafl to oligomerize into a wheel-like heptamer called an apoptosome. The Apafl proteins in the apoptosome then recruit initiator procaspasep roteins (procaspase-9) which are activated by proximity in the apoptosome, just as procaspase-8 and -10 proteins are activated in the DISC. The activated caspase-9 molecules then activate downstream executioner procaspases to induce apoptosis. As mentioned earlier, in some cells, the extrinsic pathway must recruit the intrinsic pathway to amplify the apoptotic signal to kill the cell. It does so by activating a member of the BcI2 family of proteins. Bcl2 proteins regulate the intrinsic pathway of apoptosis. Bcl2 is the mammalian homologue of the CED-9 in C. elegans.

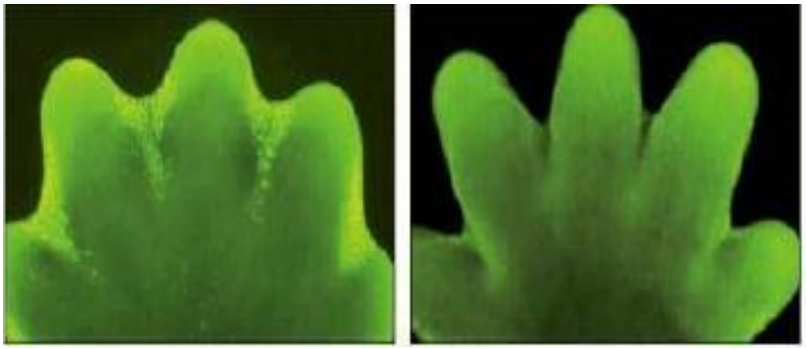
Programmed cell death during animal development:

1. Apoptosis is needed for proper development

- When a tadpole changes into a frog at metamorphosis, the cells in the tail die and the tail, which is not needed in the frog, disappear.



- The formation of the fingers and toes of the fetus requires the removal, of the tissue between them by apoptosis.



- The sloughing off of the inner lining of the uterus.
- The formation of the proper connections between neurons in the brain.

2. Cells of vertebrate adaptive immune system

Apoptosis eliminates developing T and B lymphocytes that either fail to produce potentially useful antigen-specific receptors or produce self-reactive receptors that make the cells potentially dangerous; it also eliminates most of the lymphocytes activated by an infection.

3. Apoptosis is needed to destroy cells

Examples:

1. Cells infected with viruses 2. Cells of the immune system 3. Cells with DNA damage
4. Cancer cells

Cells with DNA damage

1. Damage to its genome can cause a cell 2.to disrupt proper embryonic development leading to birth defects

3. to become cancerous 4. Cells respond to DNA damage by increasing their production of p53. p53 is a potent inducer of apoptosis

Programmed cell death during plant development

The plant life cycle alternates between multicellular generations comprising the haploid gametophytes and the diploid saprophytes.During gametophyte development, fertilization and subsequent seed development, developmentally regulated PCD (dPCD) processes are a crucial determinant of the reproductive success of a plant. PCD occurs throughout reproductive and vegetative plant development. During development of the male and female gametophytes, both gametophytic cells (synergid) as well as supporting sporophytic tissues (tapetum) need to undergo cell death for regular fertilization. After fertilization, cell death occurs in most seed tissues in the course of seed development, only the embryo proper will survive germination to form the next sporophytic generation. During vegetative development, dPCD occurs in the xylem of stems, leaves, and roots, in the root cap of some species, during aerenchyma formation and as part of organ senescence. Dehiscence and abscission processes might also involve cell death events.

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ROLE OF MICRONUTRIENTS IN SEED PRODUCTION

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Introduction:

Micronutrients have been called minor or trace elements indicating that their concentration in plant tissues are minor or in trace amounts relative to the macronutrients (Mortvedt,2000).Micronutrients are essential for the normal growth of plants. Deficiencies of micronutrient drastically affects the growth, metabolism and reproductive phase of plants.Eight trace elements are essential for higher plants: boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn).(Alloway 2008). Whenever the supply of one or more of these elements is inadequate, yields will be reduced and the quality of crop products impaired, but crop species and cultivars vary considerably in their susceptibility to deficiencies.Zinc deficiency is the most ubiquitous micronutrient problem throughout the world affecting many crops including the staples maize, rice and wheat. Boron deficiency is the second most widespread micronutrient problem and dicotyledon species tend to be more sensitive to B deficiency than graminaceous crops. Iron deficiency is important in some regions, especially those with a Mediterranean climate and calcareous soils. Copper deficiency is important in some parts of the world, such as Europe and Australia where cereals are most affected. These micronutrients are as important as major nutrients for plant development and profitable seed production.

Significance of Micronutrient in Agriculture

About four billion people will be added onto the present population by 2050 (Khoshgoftarmanesh *et al.,* 2010). This increase of population further intensified the demand for agricultural food production and to meet this demand, production should increase on the existing land (Cakmak, 2002).Green Revolution on one hand increased crop production per unit area and on other hand it also has resulted in greater depletion of soil phytoavailable micronutrients as less attention has been paid to micronutrients fertilization (Khoshgoftarmanesh *et al.,* 2010).

Micronutrient Deficiencies in Crop Plants are Widespread Due To :

Intensive cropping practices and adoption of high yielding cultivars , Enhanced production of crops on marginal soils , increased use of high analysis fertilizers ,Decreased use of animal manures, composts, and crop residues. Cultivation on soils that are inherently low in micronutrients reserves

Effects of Micronutrients Deficiencies

Yield decrease, lower crop quality ,widespread infestation of various diseases and pests , increased bio and non-bio-stresses and lower fertilizer use efficiencies

Soil Types Commonly Associated With Micronutrient Deficiencies

Geochemical composition (total micronutrient contents) of the soil parent material ,pedogenic soil type inputs of trace elements from anthropogenic sources (e.g., atmospheric deposition, pesticides, manures, fertilizers) ,adsorptive properties of the soil for retaining elements in available/unavailable forms (pH, redox status, organic matter content, calcium carbonate content and salinity) and available concentrations of macronutrients and other micronutrients

Explanations for Variations in Micronutrient Efficiency

The volume and length of roots ,Presence, or not, of proteoid roots , root-induced changes in rhizosphere pH , increased absorption through vesicular mycorrhizae, if present , release of root exudates to facilitate uptake, triggered by low Fe or Zn, organic acids, such as malic acid (Gao *et al.*, 2007).

Plant Factors Associated With Micronutrient Deficiencies

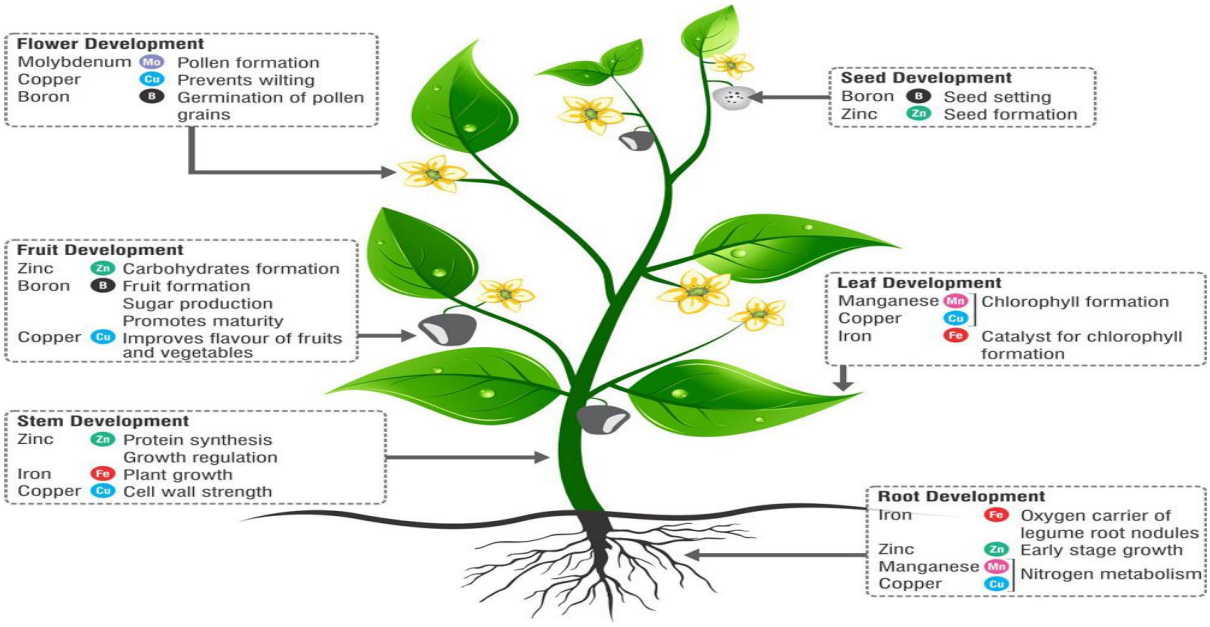
Plant genotype , nitrogen supply , phosphate supply ,moisture stress ,temperature stress ,high/low light intensity, rooting conditions ,mycorrhizal infection and secretion of root exudates, pathological disease ,agrichemicals , antagonistic effects of other micronutrients and previous crop species

Method of Application Micronutrient

Foliar Application: - Low doses of micronutrients are applied through sprays on plant foliage.Crops in younger stages require less solution, while crops more foliage or fruit trees like oranges, require more solution for spraying e.g. Fe,Mn,B.

Role of Micronutrients in Crop Development

Eight trace elements are essential for higher plants: boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn) it function , deficiency symptom and list of Zinc-containing Commercial Fertilizers.



Study on Different Crops

- T5 and T3 revealed most significant influence on all parameters under study as compared to T1 (control). Therefore, foliar application is an appropriate way to feed the tomato crop to enhance the growth, lowering and marketable yield by Ali *et al*. (2013).

- Combination of RDF + ZnSo4 @ 10 kg ha-1 + Borax 0.1% spraybud initiation stage was effective in maximum number of siliqua plant-1(363),siliqua weight plant-1 (26.30g), siliqua length (5.34cm),No. of seeds siliqua-1(5.67) and seed yield(199.93kg ha-1) by Deepika and Pitagi (2015
- Patil and Merwade (2016) reported that the results revealed that soil application of Zinc sulphate @ 25 kg ha-1and foliar application of 0.2 % borax had shown the highest number of seeds (36.17), seed weight per plant (122.38 g), seed yield (32.57 q/ha).
- Soil application of B at 1.5 kg ha-1 was the most cost effective in improving the yield and yield contributing traits of cotton and fetching the maximum net economic returns by Saleem *et al.* (2015).
- Maximum number of umbels per plant (33.7 in *rabi* and 13.8 in *kharif*) and highest seed yield per hectare (623.3 kg in *rabi* and 599.9 kg in *kharif*) were observed for the foliar application of 0.5% FeSO4 if compared to other treatments by Sinta *et al*. (2015.)

Conclusion:

Micronutrients in crop production are important, and they deserve equal attention similar to that of macronutrients. Micronutrient deficiency drastically affects the growth and inhibits different metabolic and enzymatic activities. Application of micronutrients significantly increases the yield of cereal, vegetables, oilseed and pulse crops. Micronutrient application also enhances the uptake of nutrients like N,P,K and S. The global incidence of micronutrient deficiencies is likely to increase due to the intensification of arable farming. Micronutrients are vitally important for maintaining and increasing food crop production for a growing world population. In order to increase density of micronutrients in plants, application of micronutrients containing fertilizers through foliar application would be of greater importance.

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MODERN PLANTING SYSTEM OF ORCHARD AND THEIR FIELD PREPARATION

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When establishing a new plantation, certain actions need to be implemented to ensure the long term success of the plantation. One of these actions involves the initial land preparation which should be done prior to transplanting of the plant material.

The purpose of land preparation is to provide the necessary soil conditions which will enhance the successful establishment of the young offshoots or the tissue culture plants received from the nursery.

Critical factors to consider during this planning exercise are summarized as follows:

- Field selection;	- Irrigation design and installation;
- Availability and quality of irrigation water;	- Hole preparation;
- Mechanical actions to be implemented;	- Financial requirements and time schedule
- Chemical needs for pre-plant soil improvement;	
- Tools and equipment needed for cultivation;	
- Labour needs;	

1. Field selection

1.1 Availability of water

(i) The sustainability of the water source and distance from the field,

(ii) The quality and quantity of water available for irrigation.

1.2 Soil depth

1.3 Soil quality

When evaluating the soil quality, attention must be given to:

(i) The soil texture which will influence the water retention capacity, and

(ii) The nutrient content to determine the corrective measures necessary for soil improvement.

1.4 Soil salinity or acidity

Plant growth is influenced by either saline or acid soil conditions which, in the end, will result in a loss of potential yield.

2. Physical land preparation

2.1 Mechanical field preparation

(i) Debushing/bush clearing and removal of stones and rocks,

(iii) Ripping and levelling of t he soil.

2.2 Irrigation system installation

2.3 Soil improvement

If new soils are considered, the soil improvement programme will mostly deal with:

(i) The application of organic matter and the elimination of soil salinity.

2.4 Hole preparation

Planting System of Orchard

Laying out of orchards

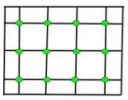
Any method of layout should aim at providing maximum number of trees per hectare, adequate space for proper development of the trees and ensuring convenience in orchard cultural practices. The system of layout can be grouped under two broad categories *viz*. (a) vertical row planting pattern and (b) alternate row planting pattern. In the former planting pattern (e.g. square system, rectangular system), the trees set in a row is exactly perpendicular to those trees set in their adjacent rows. In the latter planting pattern (i.e. Hexagonal, Quincunx and Triangular), the trees in the adjacent rows are not exactly vertical instead the trees in the even rows are midway between those in the odd rows.

The various layout systems used are the following:

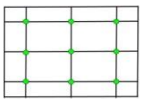
(A) Vertical row planting pattern

1. Square system: *In* this system, trees are planted on each comer of a square whatever may be the planting distance. This is the most commonly followed system and is very easy to layout. The central place between four trees may be advantageously used to raise short lived filler trees. This system permits inter cropping and cultivation in two directions.

2. Rectangular system: In this system, trees are planted on each corner of a rectangle. As the distance between any two rows is more than the distance between any two trees in a row, there is no equal distribution of space per tree. The wider alley spaces available between rows of trees permit easy intercultural operations and even the use of mechanical operations.



Square system



Rectangular system

(B) Alternate row planting pattern

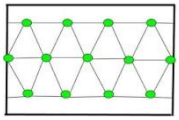
3. Equilateral Triangular or Hexagonal System: *In* this method, the trees are planted in each corner of an equilateral triangle. This way six trees form a hexagon with the seventh tree in the centre. Therefore this system is also called as 'septule' as a seventh tree is accommodated in the centre of hexagon. This system provides equal spacing but it is difficult to layout.

4. Diagonal or quincunx system: This is the square method but with one more plant in the centre of the square. This will accommodate double the number of plants, but does not provide equal spacing. The central (filler) tree chosen may be a short lived one. This system can be followed when the distance between the permanent trees is more than 10 m. The filler trees should be removed after a few years when main trees come to bearing.

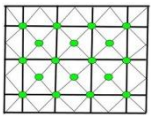
5. ***Triangular system:*** The trees are planted as in square system but the difference being that those in the even numbered rows are midway between those in the odd rows instead of opposite to them. Triangular system is based on the principle of isolateral triangle. When compared to square system, each tree occupies more area and hence it accommodates few trees per hectare than the square system.

6. ***Contour system:*** It is generally followed on the hills where the plants are planted along the contour across the slope. It particularly suits to land with undulated topography, where there is greater danger of erosion and irrigation of the orchard is difficult. The main purpose of this

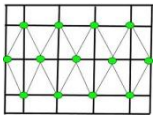
system is to minimize land erosion and to conserve soil moisture so as to make the slope fit for growing fruits and plantation crops.



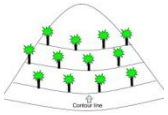
Hexagonal System



Diagonal or quincunx system



Triangular system



Contour system

7. Free style system: When planting of fruit plants is done without following any regular geometrical layout design, the system is termed freestyle system. This system is followed to plant the fruit trees on homestead lands, public building's compounds, wastelands, ravines, along railway tracks, rivers, coastal areas, factories etc.

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PEST OF BRASSICA CROPS AND THEIR MANAGEMENT

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INTRODUCTION:- Among the principal commercial crops grown in Rajasthan, the brassica crops occupy a prominent place. They play an important role in the economy of the country because of their value in import substitution. The important cruciferous oilseeds cultivated in Rajasthan are yellow and brown sarson, toria. These crops are damaged by a number of pests, of which mustard aphid, mustard saw fly, and the painted bug are more serious. The aphid is the most serious pest on brassica oilseeds throughout India (Atwal and Dhaliwal 2008).

1. Mustard aphid , *lipaphis erysimi* (Hemiptera : Aphididae)

The mustard aphid is worldwide and is a serious pest of cruciferous oilseeds and brassica vegetables (Amim *et al.* 2014). The damage done by nymphs and adults, which are louse like, pale greenish insects.

Life-cycle: This insect is most abundant from December to March. During summer it is migrated to hills. The pest breeds parthenogenetically and the females gives birth to 26-133 nymphs. They grow very fast and are full fed in 7 to10 days. About 45 generations are completed in year. Cloudy and cold weather (20°C) is very favourable for the multiplication of pest. The winged forms are produced in autumn and spring.

Damage: Both nymphs and adult suck cell sap from leaves, stems, inflorescence or the developing pods. The leaves acquire curly appearance, the flowers fail to form pods and the developing pods do not produce healthy seeds and the vitality of plant is greatly reduced. The yield of an infested crop is reduced to one-fourth or one-fifth (Kafle 2015).

Management:

(a) Early sowing, preferably upto third week of October.

(b) Apply recommended dose of fertilizer.

(c)Apply insecticides when the population of the pest reaches 50-60 aphid per 10 cm terminal portion of central shoot is covered by aphids.

Foliar sprays: one liter of oxydemeon methyl 25EC,dimethoate 30EC in 200-300 liters of water per ha.

Granular insecticides: 10 kg of phorate 10G, 33kg of carbofuran 3G per ha followed by a light irrigation.

(d)Biological control: parasitoids of aphid are *Ischiodon scutellaris* and *Syrphus serarius*. predator of aphid are *Coccinella septempunctata* and menochillus sexmaculatus.

2. **Painted bug,** *Bagarda hilarius* (Hemiptera: Pentatomidae)

The painted bug is serious pest of cruciferous crops. The damage done by nymphs and adults, nymphs are black with brown markings. Adults are sub ovate, black and have number of orange or brownish spots.

Life-cycle: The pest is active from March to December. These bugs lay oval, pale-yellow eggs singly or in groups of 3-8 on leaves, stalks, pods, and sometimes on the soil. A female lay 37-102 eggs in its life span of 3-4 weeks. The egg hatch in 3-5 days and nymphs fully develop in five stages then transform in adults. There is 9 generation in year.

Damage: Both nymphs and adult suck cell sap from leaves and developing pods, which gradually wilt and dry up. The nymphs and adult bugs also excrete sort of resinous material which spoils the pods (Dhaliwal and Arora 2014).

Management:

a. Give first irrigation 3-4 weeks after sowing as it reduces the bug population significantly.

b. Spray one liter of oxydemeon methyl25EC, dimethoate30EC in 200-300 liters of water per ha once in October and again in march-april.

c. Biological control: the eggs parasitized by *Gryon sp.* (Scelionidae), while *Alophora sp.*(Tachinidae) parasitize the adults.

3. **Mustard sawfly**, *Athalia lugens* (Hymenoptera : Tenthredinidae)

The mustard sawfly is worldwide and is a serious pest of cruciferous oilseeds and brassica vegetables. The damage done by larvae which are dark green and have 8 pairs of abdominal prologs (Atwal and Dhaliwal) .There are 16-18mm in length with 5 black stripes on the back, and the body has a wrinkled appearance. The adults are small orange yellow insects with black markings on the body and have smoky wings with black veins.

Life-cycle: The mustard sawfly breeds from October to March and the larva rest in their pupal cocoons in the ground during summer, adults emerge in early October. They live for 2-8 days and lays 30-35 eggs singly, in slits made with saw like ovipositors along the underside of the leaf margins. The eggs hatch 4-8 days and larva passes through seven stages in 16-35 days. Larva pupate in soil as water proof cocoons emerge in 11-30 days. The life cycle completed in 30-35 days. The pest completes 2-3 generations in year.

Damage: The grubs alone are destructive. They bite holes into leaves preffering the young growth and skeletonize the leaves completely. Sometimes even the epidermis of the shoot is eaten up. Although the seedlings succumb; the older plants; when attacked, do not bear seed.

Management:

d. Give first irrigation 3-4 weeks after sowing as it reduces the bug population significantly.

e. Spray one liter of oxydemeon methyl25EC, dimethoate30EC in 200-300 liters of water per ha once in October and again in march-april.

f. Biological control: *Perilissus cingulator* parasitizes the grubs. The bacterium *Serratia marcescens* causes mortality of the grubs.

4. **Diamond back moth,** *Plutella xylostella* (Lepidoptera :Yponomeutidae)

This moth is a serious pest of brassica crops like mustard, toria and also vegetables; cabbage, cauliflower. The damage done by caterpillars, when full grown pale yellowish green with black hair scattered all over the body (Hill and Foster 2000). The moth measures about 8-12mm in length and brown or grey with conspicuous white spots on the fore wings, which appear like diamond patterns.

Life-cycle: This insect is active throughout the year and lays 18-356 yellowish eggs of pin-head size in singly or batches of 2-40 on the underside of leaves. The newly hatched caterpillar bore into tissue they become full grown in 16-20 days(Talekar and Shelton). Larva constructs a barrel shaped cocoon and after 4-5 days it emerges into adult. There are several generations in year.

Damage: caterpillars damage the leaves of cauliflower, cabbage and rapeseed particularly in the heart of the first two. Central leaves of crop may be riddled and the vegetables rendered unfit for human consumption.

Management:

(a) Remove and destroy all the remnants, stubble, debris etc.

(b) Tomato, when intercropped with cabbage, inhibits or reduce egg laying by diamond back moth.

(c)Indian mustard, which attracts 80-90 per cent diamond back moths for colonization, can be used as trap crop.

(d) Spray 625ml of spinosad 2.5SC or 175 g emamectin benzoate 0.5G or 325 ml indoxocarb 15.8EC in 250liter of water per hectare.

(e) Biological control: larval stage is parasitized by *Apanteles sicarius*, *Tetrasticus sokolowskii* associated with pupa.

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NUTRITIONAL GUARD: BOTTLE GOURD OR LAUKI

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Bottle gourd also known as dudhi or Lauki is found almost in every household. Bottle gourd is yellowish green in colour and their shape is like a bottle, its pulp is white with a spongy flesh. What's making this veggie popular these days is its **enormous impact on the treatment of high blood pressure and heart disease.** The myriad of health benefits of bottle gourd is least known to many, yet unknowingly it is consumed in majority of the Indian families because of the low price tag it carries in the vegetable market and its wide availability.

Introduction:

The plants of which provide the major contribution for economically important domesticated species and many of these are earliest cultivated plants and are used for medicinal and nutritional values (Rahaman, 2013). Bottle gourd (***Lagenaria siceraria* (Molina) Standl)** or calabash is a delicately flavored Cucurbita family vegetable. Bottle gourd has long been an important component of indigenous herbal medicine, particularly in Asia (Robinson and Decker, 2004). Botanically, calabash belongs to the broader Cucurbitaceae (gourd) family of plants, in the genus *Lagenaria*. Some of the common names are *white-flower gourd, upo-squash (Filipino), long-squash*, etc., in the west and *doodhi* or *lauki* in the Indian subcontinent. Bottle gourd is a fast growing, annual climber (vine) that requires adequate sunlight for flowering and fruiting. It can be grown in a wide range of soils and need trellis support for a spread.

Its intensely branched stems bear musky, deep green, broad leaves just similar as that in pumpkins, and white, monoecious flowers in the summer. After about 75 days from the plantation, young, tender, edible fruits evolve that will be ready for harvesting. Bottle gourds come in wide range of shapes and sizes. The fruit features oval, pear-shaped or elongated and smooth skin that is light green. In the case of round or pear shaped calabash, their surface is marked by inconspicuous ridges that run lengthwise. Internally, its flesh is white, spongy and embedded with soft, tiny seeds. As the fruit begins to mature, its seeds gradually grow similar to as that in honeydew melons.

These gourds can be grown easily and have many nutritional attributes.

Health Benefits:

- Including bottle gourd in your regular diet reduces fatigue and maintains freshness especially in the summer.
- It is rich in, thiamin, vitamin C, zinc, iron and magnesium thus helping in improving overall health.
- Cooked bottle gourd is anti-bilious and it helps one relax after eating.
- Almost 96% of the bottle gourd is water which makes it very light and easy to digest. Bottle gourd is commonly used for treating indigestion, constipation, and diarrhea. Bottle gourd juice with a pinch of salt is also used to treat dehydration caused by diarrhoea.
- Very effective in the treatment of acidity and ulcers.
- It contains cucurbitacins, fibers, polyphenols and two sterols namely campesterol and sitosterol, (Ghule *et al.*2007).
- Bottle gourd is also believed to help the liver function in a balanced fashion.
- The juice from bottle gourd leaves help cure jaundice.
- If consumed with lime juice, gourd juice will effectively treat burning sensations in the urinary passage. It serves as an alkaline mixture.
- The juice of bottle gourd is a valuable medicine for excessive thirst due to severe diarrhoea, diabetes and excessive use of fatty or fried foods.
- The gourd fruit juice is used in the treatment of insanity, epilepsy and other nervous diseases.
- It has sodium and potassium making it a suitable vegetable for hypertensive patents.
- A mixture of bottle gourd juice and sesame oil acts as an effective medicine for insomnia; it should be massaged on the scalp every night.
- Bottle gourd juice also helps in the breakdown of kidney stones.
- The bitter variety is prescribed as a cardiac tonic, as an antidote to poisoning and for alleviating bronchitis, cough, asthma and biligenic affections.

- Fresh gourds contain small quantities of folates, contain about 6 µg/100g (Provide just 1.5% of RDA). Folate helps reduce the incidence of neural tube defects in the newborns when taken by anticipant mothers during their early months of pregnancy.
- It is also used in appliance of pharmaceuticals and dietary formulations (Decker *et al.* 2004).

Beauty Benefits:

- Bottle gourd juice helps reduce the asthma and biligenic affections.
- The juice from the bottle gourd leaf helps in curing baldness and aids in preventing tooth decay.
- Bottle gourd is also considered one of the best weight loss foods since it is 96 percent water and provides just 12 calories per 100 g of serving.

- ❖ Having bottle gourd juice every day or every alternate day can bring back the lost glow of the skin and enhance its complexion.
- ❖ A glass of bottle gourd juice taken daily is also considered to prevent premature graying of hair, (Hemeda *et al.* 2010).

Nutritional Facts:

- **Calories:** One cup of bottle gourd contains only 18 calories which is less than 1 percent of the daily suggested intake and is lower than many other types of vegetables, such as red potatoes which contain 150 calories if consumed in the same quantity. Therefore, if you switched from eating 1 cup of cooked red potatoes to 1 cup of cooked bottle gourd daily, you'd save 924 calories in one week, enough to lose more than ¼ of a pound.
- **Fibre Content:** Unlike many other types of vegetables, bottle gourds are low in carbohydrates. Each cup of cooked bottle gourd contains just 4g of carbohydrates. This can make bottle gourds one of the few vegetables suitable for low-carbohydrate dieting. If you're on such a diet, bottle gourds would be a much better choice than red potatoes, which contain 26g of carbohydrates per cup, or green sweet peas with 24g of carbohydrates per cup.
- **Protein Content:** Bottle gourds are low in protein as each cup contains 1g. Your body needs protein to build and repair cells and tissues, so you should always include protein rich foods in your diet unless otherwise instructed by your doctor.

Selection and storage

- ❖ Bottle gourds can be available around the season in the regions wherever suitable conditions for their growth exist. In the markets, look for fresh produce featuring tender, medium size, uniform, light green color fruit. Take a close look of its stem, which may offer a valuable hint whether the produce is fresh or aged.
- ❖ Avoid those with oversize, mature, yellow-discoloration, cuts and bruise on their surface. Tiny spots on the surface, however, would not lessen their quality.
- ❖ At home, store them in the refrigerator set at adequate humidity where they stay fresh for 3-4 days.

Preparation and serving methods

Bottle gourd is one of the most common vegetables in continuous use since ancient times. To prepare, wash the fruit in cold water and dry mop using a soft cloth or paper towel. Trim its top end in case of round or pear shaped calabash and either end in case of an elongated gourd. Peeling may not be required in case of tender fruits. Chop the produce into uniform desired chunks for even cooking.



A-Halwa **B-Barfi** **C-Ginisang-upo**

Here are some serving tips:

- Fresh calabash is used in a variety of stews, curries, sweet recipes across the world. In the Indian subcontinent where it is popularly known as *lauuki*, employed in the preparation of sabzi, sambar, chutney, soup, raita, etc.
- In India and Pakistan, its flesh is used to prepare a mouth-watering sweet dish, *lauki-ka-halwa*.
- In Africa, where it is thought to have taken its origin, calabash is used in stews with meat, poultry, and seafood.
- **Ginisang-upo** (sauteed bottle gourd) is a popular stir-fried dish among the Filipinos.

In India, bottle gourd juice is a favorite drink for its known health benefits.

Safety profile

Some bottle gourds develop naturally occurring cucurbitaceous in excess amounts under environmental adversities and may accumulate *terpenoid* toxic compounds such as *cucurbitacin B, D, G, H,* etc.

Bottle gourd poisoning is a condition that occurs when a raw bitter (toxic) bottle gourd consumed either directly or in the form of juice. Incidents of serious illness and deaths have been reported in India after consumption of bitter bottle gourd juice for its purported health benefits. Symptoms may include vomiting, stomachache, diarrhea and can occur within minutes of ingestion of poisonous juice which may follow serious illness like bleeding from the gut, shock, and death. **ICMR (Indian Council of Medical Research)** recommends the following guidelines regarding bottle gourd consumption to the public:

- ✓ A small piece of bottle gourd should be tasted before extracting the whole fruit juice to ensure that it is not bitter. If found bitter, then the whole fruit should be discarded.
- ✓ Bitter bottle gourd juice should not be consumed at all.
- ✓ Bottle gourd juice should not be mixed with any other juice.

In the case of discomfort after consumption (nausea, vomiting, diarrhea or any feeling of uneasiness), the person should be immediately taken to nearby hospital.

Interesting Facts: The bottle gourd was one of the first cultivated plants in the world, grown not for food, but as a container. They primarily used as utensils, such as cups, bowls, and basins, mostly in rural areas. It can be used for carrying items, such as fish, dirt or other foods.

- ❖ In some Caribbean countries it is worked, painted, and decorated as shoulder bags or other items by artisans and sold to tourists.
- ❖ In Jamaica there is also a reference to the natural lifestyle of Rastafarians using the gourd to make a rattle of sorts for musical festivities.
- ❖ In Haiti the plant is called ‘kalbas kouran’ literally meaning “running calabash”, and is used to make the sacred rattle emblematic of the voodoo priesthood.
- ❖ The bottle gourd plant is highly respected in many areas, so much so that it is to be the national tree of St. Lucia.

Also Remember: Bottle gourd juice if tastes bitter should not be consumed as it may cause health hazards as this produces toxic substances in it. Vegetables like bottle gourd, cucumber, pumpkin and melon though healthy but can be dangerous to health if the bitter parts are not removed before eating as they contain harmful toxins called tetracyclic triterpenoid

cucurbitacins compounds which can be poisonous if they taste unusually bitter. Hence the best way to test is to taste the bottle gourd before making the juice.

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CONSERVATION AGRICULTURE AND ITS PROSPECTS

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Conservation Agriculture

A concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment" (FAO 2007).

CA (Conservation Agriculture)is a set of soil management practices that minimize the disruption of the soil's structure, composition and natural biodiversity. Despite high variability in the types of crops grown and specific management regimes, all forms of conservation agriculture share three core principles.

- maintenance of permanent or semi-permanent soil cover
- minimum soil disturbance through tillage
- regular crop rotations to help combat the various biotic constraints

The promotion of CA under Indian context has the following prospects:

Reduction in cost of production

This is a key factor contributing to rapid adoption of zero-till technology. Most studies showed that the cost of wheat production is reduced by Rs. 2,000 to 3,000 per hectare (Malik *et al*., 2005). Cost reduction is attributed to savings on account of diesel, labour and input costs, particularly herbicides.

Reduced incidence of weeds

Most studies tend to indicate reduced incidence of *Phalaris minor*, a major weed in wheat, when zero-tillage is adopted resulting in reduced in use of herbicides.

Saving in water and nutrients

Limited experimental results and farmers experience indicate that considerable saving in water (up to 20% – 30%) and nutrients are achieved with zero-till planting and particularly in laser leveled and bed planted crops. De Vita *et al*. (2007) stated that higher soil water content under no-till than under conventional tillage indicated the reduced water evaporation during the preceding period. They also found that across growing seasons, soil water content under no-till was about 20% greater than under conventional tillage.

Increased yields

In properly managed zero-till planted wheat, yields were invariably higher compared to traditionally prepared fields for comparable planting dates. CA has been reported to enhance the yield level of crops due to associated effects like prevention of soil degradation, improved soil fertility, improved soil moisture regime and crop rotational benefits. Yield increases as high as 200 – 500 kg ha^{-1} are found with no-till wheat compared to conventional wheast under a rice-wheat system in the Indo-Gangetic plains (Hobbs and Gupta, 2004).

Environmental benefits

Conservation agriculture involving zero-till and surface managed crop residue systems are an excellent opportunity to eliminate burning of crop residue which contribute to large amounts of greenhouse gases like CO_2, CH_4 and N_2O. Burning of crop residues, also contribute to considerable loss of plant nutrients, which could be recycled when properly managed. Large scale burning of crop residues is also a serious health hazard.

Crop diversification opportunities

Adopting Conservation Agriculture systems offers opportunities for crop diversification. Cropping sequences/rotations and agroforestry systems when adopted in appropriate spatial and temporal patterns can further enhance natural ecological processes. Limited studies indicate that a variety of crops like mustard, chickpea, pigeonpea, sugarcane, etc., could be well adapted to the new systems.

Resource improvement

No tillage when combined with surface management of crop residues begins the processes whereby slow decomposition of residues results in soil structural improvement and increased recycling and availability of plant nutrients. Surface residues acting as mulch, moderate soil temperatures, reduce evaporation, and improve biological activity.

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SEED PRIMING IMPROVES PRODUCTIVITY IN VEGETABLES

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Abstract

Uniform and fast germinating seeds are of prime importance for agriculture. To improve the germination properties of seeds, different treatments are used including priming. Seed priming has been successful in improving seed vigor of many vegetable and agronomic crops, leading to rapid and uniform germination and seedling emergence. It can improve vigor especially under adverse conditions such as low/high temperatures, reduced water availability and salinity. It involves imbibitions of seeds in water under controlled conditions up to the point of radical emergence followed by drying the seed back to its initial moisture content. Seed priming is one the means by which some of these constraints can be alleviate efficiently. It is a simple, low-cost, low-risk intervention that can be a useful technology for farmers and make a positive impact on farmers' livelihoods by increasing the rate of crop emergence, increasing rates of crop development, reducing crop duration and increasing production as well as productivity.

Introduction

Vegetables are important for human nutrition and its importance is getting increase in all around of the world. Good and high crop establishment is one of the major challenges to crop production in the world and its importance is recognized by farmers as well as researchers .Vegetables constitute a major part in Indian agriculture in terms of providing food and nutritional security. In recent past, Indian agriculture has witnessed a tremendous progress in vegetable production, due to the advent of high yielding varieties and new technologies. Vegetables are important sources of minerals, vitamins and other nutrients of medicinal and therapeutic value. Regular consumption of vegetables is a must for the nutritional security of the household. The production and productivity of different vegetable crops have been increased significantly in the past twenty years as a result of research and development pursuits undertaken by agricultural institutions as well as private sectors. Modern strategic approaches are however necessary for sustainable development of these crops so as to meet increasing requirement in both domestic and export market. Constraints to good crop establishment include poor seedbed preparation, low quality seed, untimely seed sowing, and adverse weather conditions after sowing . Poor seedling emergence and seedling vigor affect crop productivity in farmers' field. Marginal and sub-marginal areas particularly in developing and under developing countries. There are so many reasons like low quality seed, inadequate seedbed preparation, untimely sowing, poor sowing technique; abiotic stresses such as drought, high temperature, salinity and adverse soil properties (e.g. crusting) etc. This urgent the necessity of simple, feasible and viable technology to improve seedling vigor and seedling establishment of crops under all environmental conditions. Rapid and uniform field emergences are two essential prerequisites to increase yield and quality in crops. Uniformity and increased seedling emergence of direct-seeded crops have major impact on final yield

and quality . Seed priming is a pre-sowing seed treatment that involves the controlled hydration of seeds, sufficient to allow pregerminative metabolic events to take place, but radical emergence does not occur. Priming allows the metabolic processes necessary for germination without protrusion of radicle. Priming is an enhancement method that accelerates germination and emergence. Increased germination rate and uniformity have been attained due to metabolic repair during imbibitions.

2. What is Seed Priming

Seed priming is a commercially used technique for improving seed germination and vigor. It involves imbibitions of seeds in water under controlled conditions up to the point of radical emergence followed by drying the seed back to the initial moisture content of the seeds .This treatment induces rapid, uniform and increased germination, improved seedling emergence, vigour and growth under diverse environmental conditions resulting in better stand establishment and the alleviation of phyotochrome-induced dormancy in some crops.

Priming is a water-based process that is performed on seeds to increase uniformity of germination and emergence from the soil, and thus enhance vegetable stand establishment. Priming decreases the time span between the emergence of the first and the last seedlings. Priming also increases the rate of emergence so the stand establishes itself faster. A uniform plant stand helps to ensure maximum cartons per acre at harvest.

The theory of seed priming was first proposed by Heydecker (1973). Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. It is a simple and low cost hydration technique in which seeds are partially hydrated to a point where pre-germination metabolic activities start without actual germination, and then re-dried until close to the original dry weight. Seed priming is employed for better crop stand and higher yields in a range of crops.

3. Techniques of Priming

The following types of seed priming are commonly used.

1. Hydropriming: It is undertaken in limited amount of water to the seeds. On farm steeping is the cheap and useful technique used in practice.

2. Osmopriming: Polyethylene glycol is commonly used as osmotic priming material. Other osmotic priming agents include glycerol, mannitol, specialized vermiculite compounds are used.

3. Matrix priming: It is the incubation of seeds in a solid, insoluble matrix (vermiculite, water absorbent polymer) with a limited amount of water. Pre-germinated seeds: Seeds are allowed to perform radical protrusion. The use of pre-germinated seeds causes rapid and uniform seedling development.

The main objectives of priming seeds include

- To alleviate phytochrome-induced secondary dormancy
- To enhance germination and subsequent crop establishment To maintain uniformity in seed emergence
- To shorten the metabolic phase ,so that emergence occurs before crusting thus crops can compete with weeds for water, space and light.

4. Beneficial Effects of Seed Priming on Seedling Establishment, Crop Growth and Productivity

a. Pre-soaking of seeds causes the hydration of membranes, proteins and the initiation of several metabolic functions .

b. Hydro-priming enhaces germination and later growth of different species such as in wheat, maize, rice and chickpea .

c. Seed priming improves rapid and uniform germination and increases seed tolerance to adverse conditions .

d. Seed priming resulted in yield improvement in cereals.

e. Priming decreases longevity.

f. Priming of seeds of different crops can alleviate the adverse effects of salinity stress and enhance crop yield . Seed priming with KNO3 (0.2%) increases significantly germination, root and shoot length and seedling vigour in maize. Osmopriming of seeds with NaCl nullify the adverse effects of salt stress.

6. Effect of priming treatments on seed vigour improvement in some of vegetable crops

To improve vegetable stand establishment, priming techniques including osmopriming, solid matrix priming and hydropriming can be used. Seed priming is a pre-sowing physiological seed enhancement treatment involving the controlled hydration of seeds. Hydration is sufficient to allow pregerminative metabolic activation to take place, but insufficient to allow radicle protrusion through the seed coat .This technique has been used in some vegetable seeds to increase the seed vigor, the germination speed, total germination rate and seedling uniformity, mainly under unfavorable environmental conditions. The technique can lead to better crop stands and higher crop yields.

Seed germination and emergence of parsley growing period especially in early spring, summer and late autumn are critical. Parsley is one of the most important vegetable that seed germination has taken long time and it is difficult to be germinated it especially under unfavorable environmental conditions. The germination percentage of parsley seed is lower than 55-75% in these kinds of conditions. Thus, slow emergence and low emergence rate lead to smaller seedlings. However, uniformity and rapidity of seed germination and emergence are essential to increase yield, quality and profits in crops. For this reason, seed priming techniques have recently been used for many plant species to increase crop stands and higher yields Also, it is reported that seed priming is a suitable method of shortening the time to early crops and obtain flexibility in processing plant schedules (Barlow *et al*., 1987).

The hybrids showed variability in different priming treatments with respect to different variables. In general, hydropriming and halopriming gave favorable response in respect of agronomic traits and yield. Cheng and Bradford (1999) did not get remarkable response to osmopriming and hydropriming on germination time in the case of tomato. In general, it is observed that emergence percentage was greater in both hydropriming treatments. In case of shoot length, both hydropriming treatments achieved greater shoot length compared to the control. With respect to root length, the responses varied in different hybrids and treatments. The response of cucumber to different priming treatments reveal that priming treatments showed beneficial effects of some agronomic variables such as plant height, number of leaves, early fruiting and number of fruits.

In the case of onion the nutriprimed (0.5 % ZnSO4for 10 h) and hormonal primed (0.2 % methionine for 8 h) seeds attained the 50 % reduction in germination on 9 and 10 days after

accelerated ageing, respectively. Whereas the unprimed seeds attained 50 % reduction in germination within 7 days after accelerated ageing.

Cabbage The response of cabbage to different priming treatments. Priming treatments showed beneficial effects of some agronomic variables such as emergence percentage, plant height, number of leaves, and leaf length. In all the treatments mentioned above cabbage showed remarkably greater growth specially in hydropriming-I and halopriming compared to control

It was reported that all priming treatments improved agronomic traits. In general, days to flowering and fruiting were earlier than the control. Hydropriming-1 gave about 67% increase in yield as compared to control. Kumar Choudhary et al., (2008) studied the effect of priming and ageing on seed quality parameters of chilli. Maximum increase in germination and other seedling parameters was witnessed in halopriming and in osmopriming.

Hydropriming capsicum seeds for 0 to 12 h also resulted in lower days to emergence. An increase in hydropriming durations resulted in an increase in the seedling emergence, energy of emergence, seedling vigor and emergence index. Therefore, the study suggested the use of hydropriming as a simple and cost-effective strategy in pepper production, especially in developing countries (Adebisi et al. 2013).

Chemo priming in french bean with GA3 and Ethrel improved the seed quality and showed improved seedling length, seedling dry weight which in turn improved higher seedling vigour index, germination speed and mean germination time. Significant increase in initial (6.02 cm) and final (11.5 cm) root length, initial and final shoot length, seedling vigour index and dry seedling weight with GA3 is observed in the crop.(Sarika *et al*., 2013).

NaCl priming on salt tolerance in melon seedlings grown under saline conditions. They reported that NaCl priming of melon seeds increased salt tolerance of seedling by promoting K and Ca accumulation, besides inducing osmo regulation by the accumulation of organic solutes(Sivritepe *et al*., 2002)

7.Conclusion

Seed priming has been used to improve germination, reduce seedling emergence time, improve stand establishment and yield. The beneficial effects of priming have been demonstrated for many field crops. It is the best solution of germination related problems especially when crops are grown under unfavorable conditions. Many priming techniques have been evolved which are being utilized in many crops now days. It can enhance rates and percentage of germination and seedling emergence which ensure proper stand establishment under a wide range of environmental conditions. The effects of seed priming depend on the crop species. Seed priming is safe, effective and easily adopted by farmers. It also has the potential to benefit such farmers in many ways and hence, its importance is recognized by farmers as well as researchers. Priming increased the percentage of germination of parsley in this study. Therefore, parsley seed should be primed in order to perform better under unfavorable environmental conditions.

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THERMOSENSITIVE-GENETIC MALE STERILITY SYSTEM IN HYBRID RICE SEED PRODUCTION

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Thermosensitive-Genetic Male Sterility (TGMS) system is governed by nuclear gene expression via influence of temperature on the expression of male sterility or fertility. Most TGMS lines show male sterility at high temperature (day temperature >30 ºC/night >24 ºC) and they revert back to partial fertility at a temperature lower than critical temperature. Reverse TGMS (rTGMS) lines are sensitive to low temperature (16 ºC night) for the expression of male sterility, whereas, at a higher temperature (>30 ºC day/24 ºC night), they become male fertile. In TGMS system A- line (male sterile) is used as female parent which is raised in isolated plots side by side with a pollen parent to produce hybrid seed on commercial scale. The pollen from male sterile plants is incapable of selfing, hence the seed set on it due to cross fertilization with pollen from some other but desirable pollen parent. Development of stable TGMS lines that could be used in breeding for super high-yielding two-line hybrids with assured quality and resistance to biotic and abiotic stress marks the future outlook of two-line hybrid rice breeding for the different ecological situations in which rice is grown.

Introduction

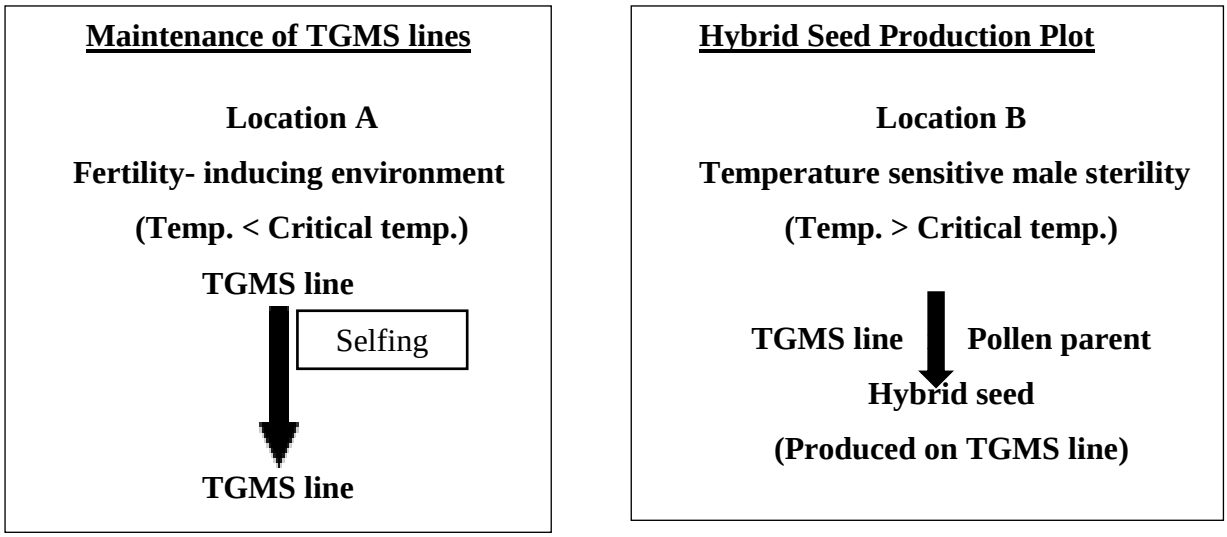
Green revolution rewards the Indian farmers with increased productivity and assured returns in terms of increased income and self-sufficiency. The high yielding semi-dwarf responsive varieties were proved a masterstroke in meeting the unmanageable demand for food grains especially for wheat and rice. However, exploitation of immense potential of the green revolution in case of rice in not fully realized on ground of, being 55-60 per cent of the rice area under un-irrigated conditions on less land and with less inputs. Thus, the real quantum jump in rice production was achieved during 1994 with the development of hybrid rice. The philanthropic policy reform, benevolent administrative support, unique convergence of technological and production capacities all together boost the rice production in country. For developing rice hybrids three-line system (cytoplasmic genetic male sterility) and two-line system (environment-sensitive genic male sterility and chemically induced male sterility) are generally used. Among the alternatives, TGMS based hybrid rice production prove to be a better choice in Indian perspectives on account of economics as well as prevailing climatic conditions.

Production of hybrid seed

The production of TGMS rice hybrids involves two major steps:

(1) Maintenance and multiplication of TGMS lines

(2) Hybrid rice seed production



Maintenance and multiplication of TGMS lines

Maintenance of TGMS line is achieved by its selfing in fertility-inducing environment. Transplanting of TGMS lines should be managed in such a way that, at the sensitive stage the temperature is most favorable for a higher seed set. At the onset of flowering, about 100 desirable plants (scored for pollen fertility) in a TGMS maintenance plot are selected, bagged and allowed for selfing. Following the harvest, bagged panicle are scored for spikelet fertility (calculated by the number of filled spikelets divided by total spikelets per panicle, multiplied by 100) and 50 plants with higher spikelet fertility (above 30%) are selected. From each of the selected plants 50 seeds are taken, half of seed is used to grow single-row progenies in sterility inducing medium and the remaining seeds are stored carefully. The lines that are uniform and completely male sterile are identified and the respective balance seed of these lines stored earlier are bulked to get the nucleus seed. Breeder seed for the TGMS line is produced using nucleus seed under the direct supervision of the plant breeder in the fertility-inducing environment. The breeder seed thus produced is used for multiplication of foundation seed of parental lines, from which certified hybrid seed is multiplied.

Pollen fertility is scored by taking five apical spikelets from the panicle on the primary tiller from selected plant and immersing them in a prepared fixative solution (alcohol: acetic acid, 3:1). The anthers are squashed in 1–2 drops of 1% acetocarmine and the fertile pollen is observed under a microscope. The fertile pollen grains will be spherical and darkly stained, whereas the sterile pollen grains will be either unstained and spherical or unstained and irregular in shape. Pollen fertility percent is calculated as the number of stained spherical pollen grains with normal shape and size to the total number of pollen grains expressed in percentage.

Hybrid rice seed production

The pollen parent is transplanted first in two rows with a spacing of 45 cm. For easy identification of the pollen parent, the top one-third part of the leaves may be clipped off. Later, the TGMS lines are transplanted in eight to ten rows with a spacing of 15 cm in between them. The pollen parent and TGMS lines are transplanted with a spacing of 30 cm in between them. The optimum row ratio for hybrid seed production is 2–3 male lines and 8–10

female lines. About 1–2 kg of pure and authentic seed is required for an area of 2.5 acre. A minimum of 200 m distance is essential to avoid contamination from any other rice pollen source as well as to meet the set standards for genetic purity. As an alternative to space isolation, a time isolation of more than 21 days would serve the purpose of maintaining genetic purity by avoiding contaminations. For proper flowering synchronization, the pollen parent lines should be transplanted on three different dates to will provide a continuous supply of pollen during the flowering of the female (TGMS) parent, matching the pre-estimated heading date of the female line. Before flowering, rouges should be identified based on morphological characters and immediately removed, especially in hybrid seed production plots to avoid genetic contaminations. If necessary, GA_3 could be sprayed @ 40–60 g ha^{-1} in two split, the first when 15–20% of the tillers have started heading and the second two days after the first spraying, to obtain good panicle exertion for better pollen dispersal and its transfer to female panicles. At flowering, supplementary pollination techniques like using rope or bamboo poles for shaking the pollen parent to facilitate enhanced pollen transfer will substantially increase the hybrid seed setting on female plants. This operation is repeated three to four times daily during peak anthesis for 6–10 days. The second safe-period (TGMS) of conducive environmental conditions that support facilitation of proper pollen movement from the pollen parent and fertilization of the TGMS parent is crucial at this stage. At harvesting, the pollen parent lines must be harvested before that of the female lines and threshed separately to avoid admixtures. Recommended seed processing, appropriate packaging and prescribed labelling and tagging must be done as per quality standards.

Advantages of the TGMS system

- This is simpler and cost-effective system of hybrid seed production as maintainer line is not required.
- There is no need for restorer genes in the male parents so any fertile line can be used as a male parent.
- Being oligogenic, the TGMS trait can be easily transferred to any genetic background and thus provide opportunity to broaden the genetic base of female parent.
- The newly transformed line used as female parents and an open hand in choice of male parent form diverse genetic origin helps in reducing potential genetic vulnerability among the hybrids.
- This system can be used to develop indica x japonica hybrids.
- The residual problems associated with use of sterile cytoplasm and chemical hybridizing agents are reduced to a minimum.

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NANO CLAY POLYMER COMPOSITE FERTILIZERS: A NEW WAY TO ENHANCE NUTRIENT USE EFFICIENCY

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Introduction

Fertilizers have an important role in enhancing the food production in developing countries especially in India. Dr. Norman E. Borlaug the Nobel Laureate, emphasizing on the importance of the high yielding varieties- fertilizer interactions stated "If the high yielding varieties were the catalyst that ignited the green revolution, the chemical fertilizer was the fuel powered its thrust". Thus, harvesting of higher yields from the same land needs higher rates of fertilizer application and after the introduction of high yielding and fertilizer responsive crop varieties. In spite of this, it is known that yields of many crops have begun to decrease as a result of imbalanced fertilization and decrease in soil organic matter. Moreover, fertilizer use efficiency is about 20- 40 percent for nitrogen (Ladha et al., 2005) and 15-25 percent for phosphorus (Malhi et al., 2002) fertilizers implies that food production will have to be much more efficient than ever before. To overcome these entire draw backs a smarter way i.e., nanotechnology can be one of the source. Nanotechnology is the understanding and control of matter of sizes roughly in the range of 1 to 100 nanometers. If one of the dimensions is in this range it is considered a nanoparticle. Synthesis or modified of NCPC nano based fertilizer would be new technology in this field which may concern. NCPC (Nano) fertilizers are synthesized or modified form of traditional fertilizer by polymerization reaction with used of different chemicals, with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces. Nano-particles can make from fully bulk materials. At nano scale physical and chemical properties are differ than bulk material. Rock phosphate if use as nano form it may increase availability of phosphorus to the plant because direct application of rock phosphate nano particles on the crop may prevent fixation in soil system because no silicic acid, iron and calcium for fixation of the phosphorus ultimately it increase phosphorus availability to crop plant.

Formulations Methods of (NCPC) Nano Fertilizers

Nanotechnology has provided the feasibility of exploring nano-scale or nano-structured materials as fertilizer carrier or controlled release vectors for building of smart fertilizers. The loading of nutrients on the Nanoparticles is usually done by –

1. Absorption on nano-particles.
2. Attachment on nano-particles mediated by ligands.
3. Encapsulation in nano-particulate polymeric shell.
4. Entrapment of polymeric nano-particles.
5. Synthesis of nano-particles composed of the nutrient itself.

Important properties of NCPC fertilizers which facilitate higher nutrient use efficiency

The NCPC fertilizers have higher surface area it is mainly due to very less size of particles which provide more site to facilitate different metabolic process in the plant system result production of more photosynthets. Due to higher surface area and very less size they have high reactivity with other compound. They have high solubility in different solvent such as water. Particles size of NCPC fertilizers is less than 100 nm which facilitates more penetration of NCPC particles in to the plant from applied surface such as soil or leaves. NCPC fertilizer have large surface area and particle size less than the pore size of root and leaves of the plant which can increase penetration into the plant from applied surface and improve uptake and nutrient use efficiency of the nano-fertilizer. Application of nano particles are many-fold. Its high surface area to volume ratio provides high reactivity as well as its small size provides better penetration into soil, plants and uptake of the nutrient.

Fertilizers encapsulated in NCPC particles will increase availability and uptake of nutrient to the crop plants. Zeolite based nano-fertilizers are capable to release nutrient slowly to the crop plant which increase availability of nutrient to the crop though out the growth period which prevent loss of nutrient from denitrification, volatilization, leaching and fixation in the soil especially NO_3-N and NH_4-N. Particle size below 100 nm NCPC particles can use as fertilizer for efficient nutrient management which are more eco-friendly and reduce environment pollution. Main reason for high interest in fertilizers is mainly their penetration capacity; size and very higher surface area which is usually differ from the same material found in bulk form. This is partially due to the fact that nano particles show a very high surface: volume ratio. Thus, the reactive surface area is proportionally over represented in nano particles compared to larger particles. Particle surface area increases with decreasing particle size and the surface free energy of the particle is a function of its size. Similar result obtained.

Advantages of (NCPC) Nano Fertilizers

1. Increase nutrients use efficiency
2. Nontoxic and less harmful to environment and humans
3. Slow and controlled release of nutrients
4. Minimize cost and maximize profit
5. Increase crop yield and profitability
6. Extended effective duration of nutrient supply of fertilizers into soil
7. Reduce fate of nutrients
8. Reduce overall fertilizer consumption
9. Improvement in the nutritional content and quality of crops

Achievements of NCPC (Nano) fertilizers

NCPC fertilizers providing greater role in crop production and several research study revealed that NCPC fertilizers enhanced growth, yield and quality parameters of the crop which result better yield and quality food product for human and animal consumption. NCPC have important role to an improvement for three major areas of production.

1. Yields: Several investigators has revealed that application of NCPC fertilizers significantly increase crop yield over control or without application of NCPC fertilizer it is mainly because of increasing growth of plant parts and metabolic process such as

photosynthesis leads to higher photosynthesis accumulation and translocation to the economic parts of the plant. Foliar application of NCPC particles as fertilizer significantly increases in yield of the crop.

2. Nutritional Value: NCPC fertilizers provide more surface area and more availability of nutrient to the crop plant which help to increase these quality parameters of the plant (such as protein, oil content and sugar content) by enhancing the rate of reaction or synthesis process in the plant system. Application of Zn and Fe on the plant increase total carbohydrate, starch, chlorophyll, IAA and protein content in the grain. NCPC nano Fe_2O_3 increase photosynthesis and growth of the peanut plant.
3. Health: Some nutrient also responsible disease resistance to the plant and due to the more availability of NCPC nutrient to the plant it prevent from disease, nutrient deficiency and other biotic and abiotic stress which indicate that NCPC fertilizers enhance overall health of the plant. ZnO nano particles also helpful to plant under stress conditions.

Conclusions

Nanotechnology has great potential in agriculture and allied fields as it can enhance the quality of life through its application in fields like sustainable and quality agriculture and the improved and rich for community. Effective uses of NCPC fertilizer enhance nutrient use efficiency in crop production. Nano fertilizers improve crop growth and yield up to optimum applied doses and concentration but they also have inhibitory effect on crop plant if concentration is more than the optimum which result reduces growth and yield of the crop.

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SEED PRIMING: NEW COMPREHENSIVE APPROACHES IN CROPS

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Introduction

Seed is the integral factor in crop production. From the time immemorial seed quality is regarded as a cardinal element in the development of agriculture and evidences of this has been observed in old Vedic literatures. In Manu Smriti it is called as that "Subeejam Sukshetre Jayate Sampadyathe" that means good seed in good soil yields abundantly. The requisite for good quality seed for increased production was identified as early as in the beginning of twentieth century. Seed priming is a pre-sowing treatment which leads to a physiological state which enables seed to germinate more efficiently and rapidly. The majority of seed treatments are based on seed imbibition permission the seeds to go through the first reversible stage of germination but do not allow radical protrusion through the seed coat. Seeds keeping their desiccation tolerance are then dehydrated and can be stored until final sowing. During subsequent germination, primed seeds show a faster and more synchronized germination and young seedlings are often more vigorous and resistant to abiotic stresses than seedlings obtained from unprimed seeds. Priming often involves soaking seed in predetermined amounts of water or limitation of the imbibition time. The imbibition rate could be somehow controlled by osmotic agents such as PEG and called as osmopriming. Halopriming implies the use of specific salts while "hormopriming" relies on the use of PGR. Some physical treatments (UV, cold or heat.) also provide germination improvement thus suggesting that priming effects are not necessarily related to seed imbibition. Priming technique is the need of present time to get the enhanced germination and establishment in maize in order to utilize the soil moisture and solar radiation to a maximum extent. In this way plants would be able to complete their growth before the stresses arrive (Subedi and Ma, 2005).

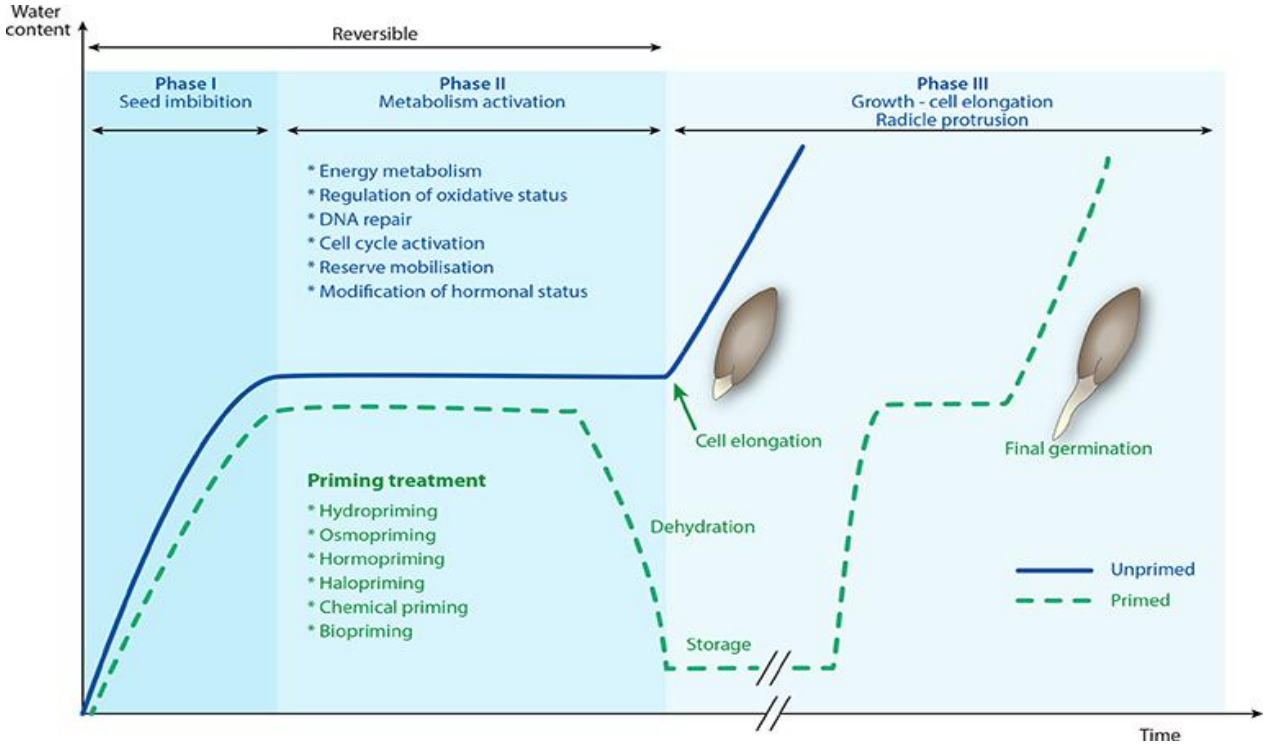
Physiological and Biochemical Aspects of Priming

Priming also has been shown to induce nuclear DNA synthesis in the radical tip cells in tomato (Liu *et al.*, 1997) and several other plant species, including maize. (Garcia *et al.*, 1995). Osmopriming has been shown to activate processes related to cell cycle. In wild rye seeds, for example, priming with 30% PEG for 24 h resulted in increase in the activity of superoxide dismutase (SOD) and peroxidase (POD) and a rapid increase in the respiratory intensity, which were associated with an increase in germination vigor.

Seed Germination

Germination is an important stage of seedling establishment and therefore it plays a key role in crop production. Crop establishment however depends on the interaction between seedbed environment and seed quality (Perry, 1984) where salinity has been identified as one of the major seedbed factors influencing establishment. Priming is one important physiological method which improves the seed performance and provides faster and

synchronized germination. The primed seeds give earlier, more uniform and sometime greater germination and seedling establishment and growth.



Seed Priming Techniques

1. Hydro-Priming : Soaking the seeds in water before sowing (Pill and Necker, 2001) and may or may not be followed by air-drying of the seeds. In many agricultural areas, a major cause of poor stand establishment and low crop yield is unfavorable environmental conditions for seed germination and seedling emergence. However, rapidly germinating seedlings could emerge and produce deep roots before the upper layers of the soil are dried out and crusted, which may result in good crop establishment and higher crop yield.

2. Halo Priming: Halo priming refers to soaking of seeds in solution of inorganic salts i.e. NaCl, KNO3 CaCl2, CaSO4, etc. A number of studies have shown a significant improvement in seed germination, seedling emergence and establishment, and final crop yield in salt affected soils in response to halopriming. Khan *et al*. (2009) evaluated the response of seeds primed with NaCl solution (1 mM) at different salinity levels 0, 3, 6 and 9 dSm-1 in relation to early growth stage and concluded that seed priming with NaCl has been found to be better treatment as compared to non-primed seeds in case of hot pepper for improving the seedling vigour and stand establishment under salt- stressed conditions.

3. Osmopriming: This is also known as osmo-conditioning or osmotic conditioning. In this technique, seeds are soaked for a certain period in solutions of sugar, polyethylene glycol (PEG), glycerol, sorbitol, or mannitol followed by air drying before sowing. Osmopriming not only improves seed germination but also enhances general crop performance under nonsaline or saline conditions, osmo-conditioning of Italian ryegrass.

4. Hormonal Priming: It the pre seed treatment with different hormones i.e. salicylic acid, ascorbate, kinetin, etc. which promote the growth and development of the seedlings. The interactive effects of salinity stress (40, 80, 120 and 160 mMNaCl) by soaking wheat seeds in ascorbic acid and thiamin (0.3 mM) or sodium salicaylate (0.6 mM) (Hamada and al-Hakimi,

2001). The contents of cellulose, lignin of either shoots or roots, pectin of roots and soluble sugars were lowered with increase of NaCl concentration.

5. Biopriming: Biopriming is a seed treatment which combines the inoculation of seed with beneficial microorganisms (biological aspect) and regulation of seed hydration (physiological aspect) for biotic and abiotic stress management (Bisen *et al*., 2015)

Conclusions

Seed priming is an old empirical strategy used since centuries by farmers, and since decades by seed companies, to improve germination processes in cultivated plant species in plant breeding. Seed priming is an environmentally safe and effective technology which can be easily adopted by resource-poor farmers and benefited the farmers in a number of ways. It is the best solution of germination related problems especially when crops are grown under unfavorable conditions. Many priming techniques have been evolved which are being utilized in many crops now-a- days. Among these hydro-priming, halopriming and osmopriming are most common and popular techniques in seed science and technology.

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DNA REPLICATION AND REPLICATIVE SENESCENCE

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DNA replication is the process of synthesis of two identical daughter replicas of DNA from the original parental DNA molecule. This universal event form the basis of biological inheritance and at the same time claimed its essentiality for perpetuation of cell. DNA is made up of a double helix of two complementary but anti-parallel strands, which get separated during the replication initiation at origin of replication and act as a template for the synthesis of its complementary strand. After the replication process is completed the new replicas have one parental and one daughter strand in double stranded helix. This manner of replication is known as semiconservative replication which is the most accepted mode of DNA replication and established via experiments. In every cycle of DNA replication, a portion of DNA at 3' end of lagging strand remains unreplicated (which is well known as end replication problem) and they shorten until reaching a critical length that signals replicative senescence.

DNA Replication

The perpetuation of life duly relies on the underlying mechanism of secure storage of genetic information on the DNA and its reliable passing to subsequent generations. This could be achieved with a precisely regulated copying of the information that the cell contained on its DNA. This involves a complex system of enzymes, nucleotides, template information and different regulatory sequences that replicates the stored information and paves way for its reliable transfer. In a cell, DNA replication begins at specific locations, known as origins of replication that are mostly A/T rich sequences. When both strands open up, a Y shaped replication fork is

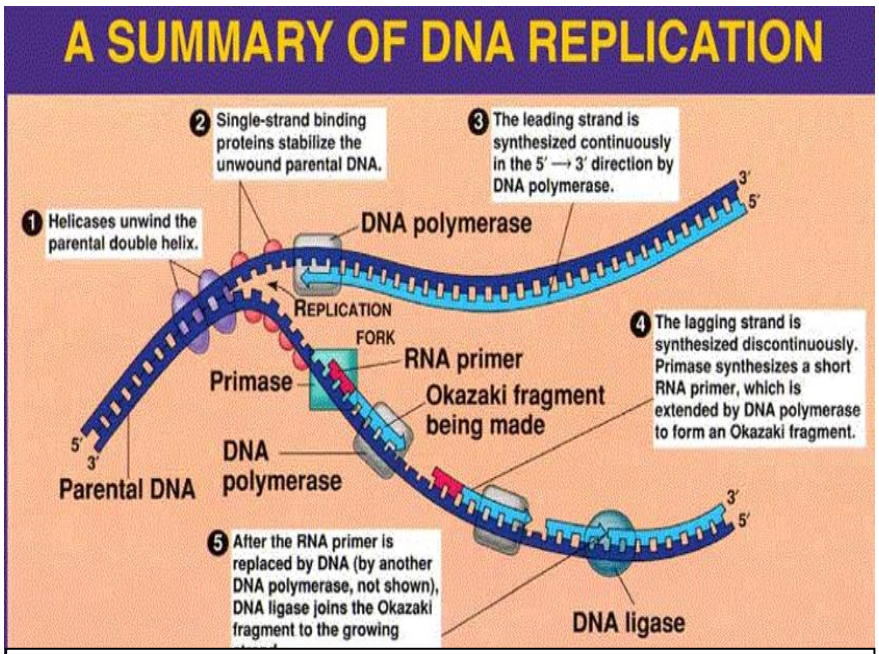


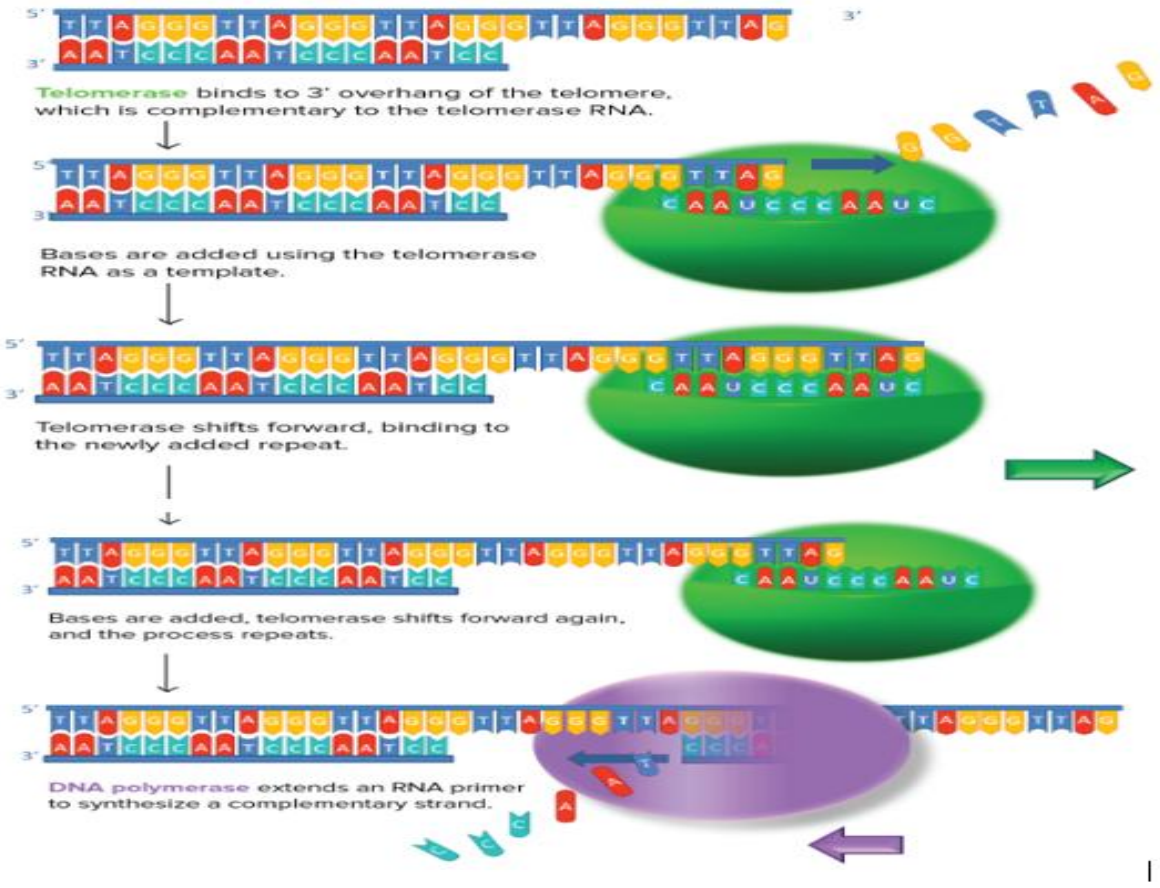
Fig.: A summary of DNA replication from DNA Replication at Think Quest. Source: Google images

generated from where replication initiates and then proceeds in bidirectional manner. Unwinding of DNA at the origin and synthesis of new strands, accommodated by an enzyme known as helicase, results in replication forks growing bi-directionally from the origin. A number of proteins viz. helicase,
gyrase, topoisomerase, SSB, ligase, primase, polymerase, telomerase etc. are associated with the replication fork to help in the initiation and continuation of DNA synthesis. Most prominently, DNA polymerase-III synthesizes the new strands by adding nucleotides that complement each (template) strand. DNA replication occurs during the S-stage of interphase DNA replication, like all biological polymerization processes, proceeds in three enzymatically catalyzed and coordinated steps: initiation, elongation and termination via different modes like that replication, rolling-circle replication, strand displacement replication, D-loop replication and linear eukaryotic replication. DNA replication is a highly coordinated and precised activity for transfer of genetic information through generations. However, it also provides an opportunity for minor variations that drive evolution. DNA replication fidelity with emphasis on structural and biochemical studies of DNA polymerases that provide new insights into the importance of hydrogen bonding, base pair geometry, and substrate-induced conformational changes is a key determinant of genome stability and is central to the evolution of species. Cellular proofreading and error-checking mechanisms ensure near perfect fidelity for DNA replication. DNA is always synthesized in the 5' to 3' direction. Since the leading and lagging strand templates are oriented in opposite directions at the replication fork, a major issue is how to achieve synthesis of nascent (new) lagging strand DNA, whose direction of synthesis is opposite to the direction of the growing replication fork. The leading strand is the strand of nascent DNA which is being synthesized in the same direction as the growing replication fork. The lagging strand is the strand of nascent DNA whose direction of synthesis is opposite to the direction of the growing replication fork. Because of its orientation, replication of the lagging strand is more complicated as compared to that of the leading strand. As a consequence, the DNA polymerase on this strand is seen to "lag behind" the other strand. The lagging strand is synthesized in short, separated segments. On the lagging strand *template*, a primase reads the template DNA and initiates synthesis of a short complementary RNA primer. A DNA polymerase extends the primed segments, forming Okazaki fragments. The RNA primers are then removed and replaced with DNA, and the fragments of DNA are joined together by DNA ligase. Finally, the newly synthesized daughter strands joined together by base pairing, as well the separated parent strands do so and the information is copied and multiplied from parent to daughter strands.

Replicative Senescence

Normally a human cells undergoes a predefined and finite number of cell divisions and ultimately enter a non-dividing state called replicative senescence triggered by erosion and dysfunction of telomeres and is mediated by multibranched signaling processes. telomere shortening. It has been proposed that, at each cell division, the average length of telomeres in the lagging strand gradually shorten by 20–200 base pairs. One reason for this shortening is the so-called “end replication problem”: i.e. the incomplete replication of the linear ends. This problem could be efficiently managed by reverse transcriptase activity of Telomerase catalytic component (TERT) that extends the 3’ end of the lagging strand by adding the

repeats at terminal using a RNA component(TERC) serving as a template for telomeric synthesis and provide a space for the RNA primer binding at 3' end. Once the RNA primer become capable of binding it initiates DNA synthesis in 5'-3' direction followed by the extension of unreplicated portion by DNA polymerase –III, thus circumventing the replicative senescence.



Source: Image modified from "Working principle of telomerase**," by Fatma Uzbas (**CC BY-SA 3.0**). The modified image is licensed under a** CC BY-SA 3.0**license._**

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INTEGRATED STRATEGIES FOR HIGH DENSITY PLANTING (HDP) IN FRUIT CROPS

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Introduction:

Accommodating more number of plants per unit area in comparison to normal planting is known as HDP. It was first attempted successfully in Europe at the end of 1960 in undertaking apple plantation. High density planting technique is a modern method of fruit cultivation involving planting of trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operations. It enables profitable cropping, high regular yields and improved farm management practices, leading to higher productivity. Today new orchards of fruits are being attempted to plant in this system with a view to produce higher fruit yield and increased profit per unit area. Advancing knowledge in tree architecture, growth physiology, possibility of using growth retardants has enabled farmers to adopt closer planting and maintaining reachable canopy. The area under fruit crops in India during 2017-18 was 6.50 million hectares with production of 97.35 million tons fruits. In India, HDP has been successfully attempted in apple, peach, pear, banana, pineapple, guava, mango and citrus. An optimum tree density is the level of density which is required to facilitate optimum light distribution and interception leading to high photosynthesis. As a result, yield per hectare is maximized. In HDP, planting intensity is maintained many times higher than normal planting.

Accordingly,

Semi-intensive	:	500-1000 trees/ha
Intensive	:	1000-10000 trees/ha
Meadow orcharding	:	20000-100000 trees/ha

Strategies for intensive orcharding (HDP) –

1. Planting system- Planting system is a combination of tree arrangement and plant form. Tree arrangement in HDP system must have sufficient alleyways for movement of farm machinery and aimed to achieve high assimilated production for its conversion into economic yield. Various planting systems adopted in fruit crops -square, triangular, quincunx, rectangular, hexagonal, hedgerow (single & double), paired planting and cluster planting. Square and triangular systems are followed for HDP in mango, kinnow, banana, papaya and Hedge row system in apple and pineapple in India.

Spacing at different planting systems are as follows:

Crops	Normal planting system (m)	HDP system (m)	Meadow orcharding (m)
Mango	7.5 X 7.5 - 12.5 X 12.5	3 X 2.5 - 5 X 5	2.5x2.5 – 3x1
Banana	2 X 2 - 2 X 3	1.5 X 1.5 - 1.8 X 1.8	1.2x1.2 - 3x0.5
Citrus	6 X 6 - 8 X 8	3 X 6 - 3 X 4.5	-
Papaya	2 X 2 - 3X 3	1.8 X 1.8	1.2x1.2 – 1x1
Guava	6 X 6 - 8 X 8	3 X 3 - 3 X 1.5	2x2 - 2x1
Sapota	10 X 10	5 X 5	-

Aonla	10 X 10	5 X 5	-
Apple	10 X 10	3 X 0.75	3x0.37 - 0.60

2. Tree size control- Canopy management is the manipulation of tree canopies to optimize its production potential with excellent quality fruits. The canopy management, particularly its components like tree training and pruning, affects the quantity of sunlight intercepted by trees, as tree shape determines the presentation of leaf area to incoming radiation. Managing a canopy will help to develop a strong tree that will support heavy crop loads, while increasing fruit production and improving fruit quality in the long-term.

i.) Use of dwarf rootstock/interstock-

Crop	**:**	**Dwarf rootstocks**
Apple	:	M9, M26, M27, Bud.9, P22 & Ottawa3
Pear	:	Quince C
Peach	:	Krymsk 1 & Krymsk 2
Plum	:	Pixy
Cherry	:	Colt and Charger
Ber	:	*Zizyphus rotundifolia*
Mango	:	Vellaikolumban
Guava	:	Pusa Srijan, *P. friedrichsthalianum*, *P. pumilum*
Citrus	:	Troyer citrange, Flying Dragon & *Severinia buxifolia*

ii.) Adoption of dwarf scion varieties-

Crop	**:**	**Genetically dwarf scion cultivars**
Mango	:	Amrapali, Arka Aruna
Papaya	:	Pusa Nanha
Banana	:	Dwarf Cavendish & Robusta
Apple	:	Spur varieties like Red Chief, Oregon Spur
Cherry	:	Compact Lambert, Meteor and North Star
Peach	:	Redheaven
Sapota	:	PKM1 & PKM3

iii.) Use of growth regulators- The general target for growth retardent compounds is to alter assimilate partioning in favour of reproductive parts at the expense of vegetative shoot growth by acting on endogenous gibbrerellin biosynthesis. Commercially adopted are - Cycocel (CCC), Ancymidal, Paclobutrazol , B-9 (Phosphon D) and Chloramquat. Such compounds make it to possible to reduce vegetative growth while at the same time also improving tree productivity and quality.

iv.) Training system- The training begins when the tree is first planted and continues throughout its productive life. Proper tree forms, branch angle and limb spacing in it-self aids in growth control. Spindle bush, cordon, espalier, tatura-trellis, Y-trellis etc. system of training have been found useful for maintaining the plant dwarf in shape which is desired in HDP.

v.) Shoot and root pruning- In high density planting, the main objective of pruning is to develop plant form which is good in light distribution, small in size and easy to manage especially in terms of mechanization.

vi**.) Suitable crop management practices-** Another component in high density planting is the system automation which contributes to high production efficiency. One of the important farm operations that can be automated is irrigation and fertigation *vis-à-vis* indiscriminate mechanical pruning. Apply nutrients and plant protection measures timely in adequate quantity.

Comparison between traditional planting system and HDP system:

Sr.No.	Parameters	Traditional system	HDP system
1.	Basic need	Vigorous cultivars	Dwarf cultivars
2.	Establishment cost	Low	High
3.	Tree number	150-200 tree/ha	500-2000 tree/ha
4.	Bearing	Long juvenile period (6-8 years)	Short juvenile period (2-3 years)
5.	Harvesting date	Normal	May be hasten or delay
6.	Production	Low	High
7.	Fruit quality	Poor	Better
8.	Mechanization	Does not require extensive mechanization	Require extensive mechanization
9.	Management	Difficult to manage due to large size of tree	Easy to manage due to small size of tree
10.	Utilization of natural resources	Low	Efficiently high

Source: Ray, P.K. (1999)

A**dvantages of HDP:**

- Efficient utilization of resources soil, water, solar radiation etc.
- Facilitates more efficient use of inputs- seeds, plants, manures, fertilizers chemicals (fungicides, weedicides & pesticides), machineries etc.
- Reduces labour cost resulting in low cost of production.
- Enables the mechanization of fruit crop production.
- Induces precocity, increases yield and improves fruit quality ultimately higher economic return.

Reasons for slow adoption of HDP:

- Lack of standardization of production technology and extension of technical-knowledge to the farmers.
- High initial establishment cost of orchard.
- Lack of promising dwarfing rootstock in mango, guava, sapota, peach, sweet cherry etc.
- In apple, commercial utilization of dwarf rootstocks for tree size control in HDP is restricted due to their poor anchorage, occurrence of sloppy, shallow and rain-fed lands and low fertility.
- High incidence of some diseases in HDP e.g. Sigatoka leaf spot & finger tip in banana.

Future thrust : There is need to more research work on extent and time of training & pruning, adoption of mechanization, screen the varieties having less vigorous and erect in growth habit and use of growth regulators to retard vegetative growth and improve qualitative production in each fruit crops for increasing farm income per unit area and ultimately improving farmers livelihood.

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LASER ASSISTED PRECISION LAND LEVELER: A PRECURSOR TECHNOLOGY

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Introduction: Stagnating yield and declining input use efficiency coupled with diminishing availability of water for agriculture is a major concern of food security in India. The objective of precision land leveler is to establish an understanding of how crop yield and input use efficiency can be improved and how land leveling and crop establishment practices can be modified to be more efficient in water use. Laser-assisted precision land leveling (PLL) is the foremost step in the judicious use of irrigation water and enhancing water productivity. It is a laser-guided (light amplification by stimulated emission of radiation) precision leveling technique used for achieving very fine leveling with the desired grade on the field within ±2 cm of its average micro elevation.

Needs of precise land leveling:

- The development of laser leveling technology as second only to the breeding of high-yielding crop varieties for meeting challenges of food security.
- Precision land leveling will increase the water application efficiency and consequently increase the yield of crops.
- It can help even the distribution of soluble salts in salt-affected soils, increase cultivable land area due to reduction in bunds and channels in the field, reduce weed intensity, increase fertilizer use efficiency, increase crop yields, and result in saving in irrigation through elimination of unnecessary depression and elevated contours.

Types of laser land levelers:

- **Manual leveling lasers-** Set-up of a laser leveling instrument requires the operator to manually level the unit by using the units' screws and bubble vials. These lasers rely on tubular bubbles for leveling. The user needs to level the laser in both the X-axis and Y-axis and rely on the bubbles for accuracy. These lasers can achieve a maximum accuracy of 1 cm at 100m.
- **Semi self-leveling lasers-**These lasers adjust themselves automatically within a range using a compensator. To get to a prescribed range, the laser is equipped either with a circular bubble with a bull's eye, or electronic lights that turn green when you reach the self leveling range. These lasers are very accurate and have a shut-off feature if the laser is bumped or goes out of the self-leveling range. They can achieve accuracy of at least 1 cm at 100 m.

- **Fully self-leveling lasers-** These lasers automatically find and maintain level within a specified range. These lasers are equipped with an electronic level vial and servomotors. The servo motors level the instrument electronically and when leveled, the laser starts spinning. They are the easiest to use and can achieve accuracy of up to 2.5 mm at 100 m.
- **Split-beam lasers-** These lasers emit simultaneous horizontal and vertical beams to establish both level and plumb reference lines.

Components of laser land leveling system:

- Drag bucket
- Laser transmitter
- Laser receiver
- Control box
- Hydraulic system

Environmental benefits of laser land leveling:

Laser land leveling can certainly minimize yield variability at farm level, optimize inputoutput relation and save resources like soil, water and energy. If adopted on a large scale, the laser leveling would help in improving the quantity and quality of ground water because of improved water productivity and less accumulation and deep percolation of water-soluble pesticides and chemicals, especially nitrate. It is estimated that adoption of precision land leveling system to just two million hectare of area under rice-wheat system could save 1.5 million hectare-meter of irrigation water and improve crop yields amounting to US$ 500 million in three years.

Limitations of laser leveling:

- High cost of the equipment/laser instrument
- Need for skilled operator to set/adjust laser settings and operate the tractor
- Less efficient in irregular and small sized fields

Conclusion: Therefore, a group of farmer can assist to purchase this type of equipment that increase resource use efficiency and enhance productivity of crop.

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