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Note: Articles in magazine as per publication policy

# Life Cycle and Management of Pomegranate Fruit Borer

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## *Introduction*

Pomegranate fruit borer is distributed all over India and all over the World. It is the most widespread, polyphagous and destructive pest of pomegranate fruit in standing crop. The damage of fruit borer is seen throughout the year irrespective of the bahar treatment. It is widespread polyphagous and destructive pest all over India and common in Maharashtra and all-over North places of India. Peak incidence in the month of August and is high in between November-December, month. Damage start from the flowering to button stage of period. The fruit has leathery skin or rind mainly yellow more or less overlaid with light or dark pink or dark red. The interior is separated by membranous skin and white spongy tissue into compartment packed with transparent sacs filled with tart, fleshy-juicy, red, pink or whitish pulp in color. In each sac there is one white or red, angular, soft or hard seed. The seeds represent about 52% of the weight of the whole fruit. The biology, life cycle, symptoms and management are discussed below**:**

## *Symptoms*

- ✓ The female butterfly lays eggs on flowers, buds and the calyx of developed fruits. After hatching, the caterpillars are enter the fruit and feed on the arils and inner parts of the fruit.
- ✓ The symptoms are the odious smell and excreta of caterpillars coming out of the entry holes and ultimately leading to fruit rot and damage of full mature fruit.
- ✓

**Fig. 1**: Symptoms of Anar butterfly (*Deudorix Isocrates*)

***Pest identification***

- ✓ Egg: They are laid singly on tender leaves stalks and flower buds.
- ✓ Larva: Full-grown larvae are dark brownish with short hairy and white patches all over the body surface and measures about 16 to 20mm long.
- ✓ Pupa: Pupation occurs either inside fruits or on the stalk holding it.
- ✓ Adult: Adults are glossy bluish in the case of male and brownish violet color in the case of female with a conspicuous orange patches on the forewings.

***Biology of the pest***

Adults lay eggs on the stalks or flower buds with incubation period lasting 7-10 days. The larva hatches and bores into the fruit with the larval period lasting for 18-47 days. Pupation lasts for 7-34 days and the life cycle is completed in 1-2 months.

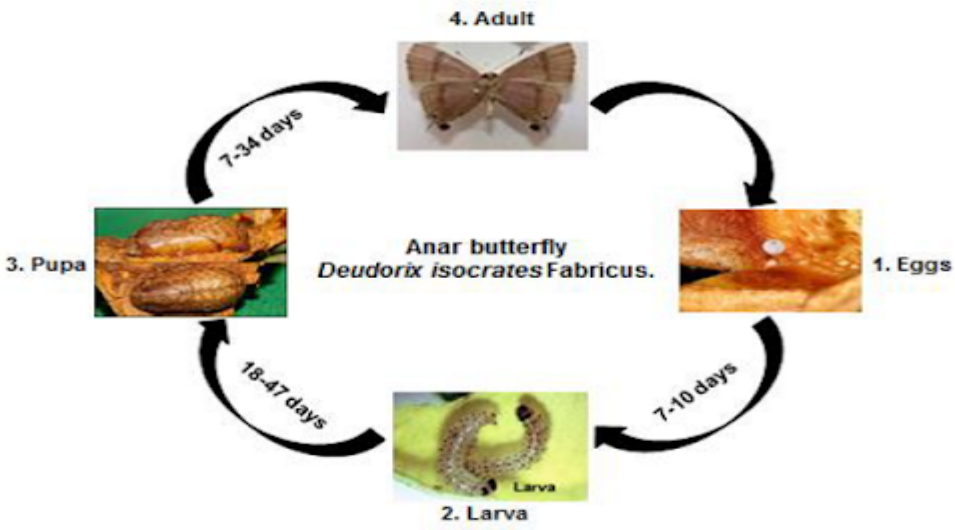


**Fig. 2**: Life Cycle of Fruit Borer

**Damage symptoms:**

- ✓ Caterpillar bores into young fruits.
- ✓ Feeds on internal contents (pulp and seeds)
- ✓ Fruit rotting and dropping may occur

**Management practices:**

- ✓ Removal and destruction all the affected fruits help to reduce the infestation.
- ✓ The fruits if covered with polythene or paper bags may escape infestation.
- ✓ Spray applications of fenvalerate 0.005%, or carbaryl 0.2 % or quinalphos 0.06% or decamethrin 0.0028% effectively controls the pest.
- ✓ Spraying with decametric at 0.0028% at the time when more than 50% of fruits have set. Repeat after two weeks with carbaryl at 0.2% or fenvalerate at 0.005%. In non-rainy season quinalphos at 0.06% was effective.

- ✓ Spraying with malathion 50 EC at 2 ml/L or carbaryl 50WP at 4 g/L or neemark at 5 ml/L or monocrotophos 36 SL at 1 ml/L of water starting from flowering to harvesting stage at an interval of 21 days for effective management of the pest.
- ✓ Spraying with methyl parathion (metacid) 50 EC at 1 ml/L or carbaryl 50 WP 0.2% can also control this pest.
- ✓ The parasitoids namely, *Telenomus* sp., *Ooencyrtus papilionis* and *Trichogramma chilotraeae* are known to cause up to 60% parasitism on *D. isocrates* in Peninsular India.
- ✓ Release T. *chilonis* at 2.5 lakh/ha, four times at ten days interval has been recommended.
- ✓ The eggs of *D. epijarbas* were found to be parasitized up to 62% by *Trichogramma* sp. in nature.
- ✓ Covering the entire orchard with nylon net followed by spray with contact insecticide has been recommended.

# Commercial Silks of the World

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## *Introduction*

Silk is the most elegant textile in the world prominently known as the "Queen of Textiles". The prime manufacturers behind the production of silk are many; out of them silkworms are the most important silk producers. They produce silk to form their cocoons which is used as a tool of protection for the pupal stage. The art and science of rearing of silkworm with an aim to produce commercial silk is called sericulture. Silk produced by the mulberry silkworm is called mulberry silk while the silks produced by other four types of silkworm are called non-mulberry or vanya silk. Among them, mulberry silkworm contributes around 90 percent of world's silk production. Rest of the silk is produced by the vanya silkworms. Apart from these commercial silks, there are many other non-mulberry silks exploited in wild habitats of Africa and Asia like Anaphe silk, Coan silk, Fagara silk, Spider silk and Mussel silk.

## *Types of silks*

There are many silks produced in the world. As mentioned earlier, silks are classified as mulberry and non-mulberry or vanya silks.

### *1. Mulberry Silk*

Mulberry silk is commercially produced by mulberry silkworm, *Bombyx mori* L., belongs to family Bombycidae of Lepidoptera order. The insect solely feeds on the leaves of mulberry plant (monophagous in nature). Depending on the number of generations per year, it may be univoltine, bivoltine or multivoltine. Generally, univoltine breeds are grown in the cooler regions of world like Japan, Russia, China etc. whereas bivoltine and multivoltine breeds are reared in the tropical regions like India, Italy, Thailand etc. Mulberry silkworm produces almost 90 per cent of the total commercial insect silk of the world. It is fully domesticated and reared indoor throughout its whole life stages. It is famous for its lustrous look, light weight, unique colour and better dying character. The silks produced by mulberry silkworm is white or yellow in colour depending on the race of silkworm.

**(Mulberry Silk)**

***2. Vanya or Non-Mulberry Silk***

***2.1 Muga Silk***

Muga silk is produced only in India which enjoys monopoly in its production in the world. Muga silk is produced by muga silkworm, *Antheraea assamensis*. Muga silkworm is semi-domesticated which is partly grown in wild form and partly as indoor. It is confined to the Brahmaputra valley of north-eastern states of India, particularly regions of Assam. It is multivoltine and polyphagous in nature. The primary host plants are som (*Persea bombycina*) and soalu (*Litsea monopetala*). Silk produced by muga silkworm is golden yellow in colour.

**(Muga Silk)**

***2.2 Tasar Silk***

Tasar silk is produced as of broad diversity in the world. There are different types of tasar silkworms like Indian tasar silkworm, *Antheraea mylitta*, temperate tasar silkworm, *Antheraea proylei,* Chinese tasar silkworm, *Antheraea pernyi* and Japanese tasar silkworm, *Antheraea yamammai*. Chinese silkworm, *Antheraea pernyi* produces the largest quantity of non-mulberry silk of the world. The next most important tasar silkworm is Indian tasar silkworm, *Antheraea mylitta* which produces silk of grey colour. Japanese tasar silkworm, *Antheraea yamammai* produces green coloured silk thread. The Chinese and Japanese tasar silkworms feed primarily on oak leaves. The Indian tasar silkworms feed on leaves of Asan, *Terminalia tomentosa*, Arjuna, *Terminalia arjuna* and several other minor host plants. The silkworms are either uni- or bivoltine and their cocoons like the mulberry silkworm cocoons can be reeled into raw silk.

**(Tasar Silk)**

### *2.3 Eri Silk*

Eri silk is white or brick-red coloured produced by Eri silkworm, *Philosamia ricini* or *Samia ricini*. The insect is multivoltine and polyphagous in nature. The primary host plant of eri silkworm is castor (*Ricinus communis*). It is a domesticated silkworm producing open ended cocoons. Hence the silk thread produced is discontinuous in nature. Apart from silk production, the pupae are used as a source of food in the tribal communities. The cocoons are non-reelable and used as spun to produce the silks out of it.

**(Eri Silk)**

### *2.4 Anaphe Silk*

Anaphe silk is produced by the silkworm that belongs to the genus *Anaphe* of family Notodontidae of Order Lepidoptera. It is an origin of southern and central Africa. It is mainly produced by silkworms of different species of genus *Anaphe* like *A. moloneyi*, *A. panda*, *A. reticulate*, *A. ambrizia*, *A. carteri*, *A. venata* and *A. infracta*. The silkworm is a polyphagous insect that chiefly feed on host plant, *Triplochiton scleroxylon.* They spin cocoons in communes, all enclosed by a thin layer of silk. The silk produced from *A. infracta* is known locally as "book" and those from *A. moleneyi* as "koko" and "Trisnian-tsamia" (Tt). The fabric obtained from Anaphe silk is elastic and stronger than that of mulberry silk. Anaphe silk is used in velvet and plush making.

**(Anaphe Silk)**

### *2.5 Coan Silk*

The silkworm which produce coan silk is called as Syrian silkworm, belongs to the genus *Pachypasa*. It is commercially produced from the Mediterranean bio-geographic region (southern Italy, Greece, Romania, Turkey, etc.). The species used for commercial production of coan silk are *Pachypasa atus* and *Pachypasa lineosa.* They feed primarily on trees such as pine, ash cypress, juniper and oak. They spin white cocoons which have dimension of 8.9 cm x 7.6 cm. In ancient times, this silk was used to make the crimson-dyed apparel worn by the dignitaries of Rome.

**(Coan Silk)**

### *2.6 Fagara Silk*

Fagara silk is produced from the giant silk moth, *Attacus atlas* and a few other related species or races. It is inhabiting in the Indo-Australian bio-geographic region, particularly in China and Sudan. They spin light-brown cocoons nearly 6 cm long with peduncles of varying lengths (2-10 cm). Total of 13 species of *Attacus* are known to produce fagara silk.

**(Fagara Silk)**

### *2.7 Spider Silk*

One of the widely known non-insect silk "Spider silk", is obtained from three species of spiders namely, *Nephila madagascarensis, Miranda aurentia* and *Epeira. Spider silk is known for its* soft and fine, but also strong and elastic nature. Because of the high cost of production, spider silk is not used in the textile industry; however, durability and resistance to extreme temperature and humidity make it indispensable for cross hairs in optical instruments. This silk is used in the manufacture of cross-bars in optical instruments.

**(Spider Silk)**

### *2.8 Mussel Silk*

It is also a non-insect silk originated from a bivalve, *Pinna squamosa,* found in the shallow waters along the Italina and Dalmatian shores of the Adriatic. The strong brown filament or byssus, is secreted by the mussel to adhere it to a rock or other ground surfaces. The byssus is combed and then spun into a silk popularly known as "fish wool" in Italy.

**(Mussel Silk)**

### *Conclusion*

Silk acts as the major source of textile industry around the globe after cotton. Silk industry acts as the bread and butter for active population in India. Globally, it shows various way of getting good foreign exchanges for silk entrepreneurs. However, the potential of unexploited silks of the world need to be realized so that silk production brings noticeable upliftment for the poor.

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# Molecular Diagnostic Tools and Techniques in Disease Management

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## *Introduction*

Accurate identity and early detection of pathogens is a crucial step in disease management and environmental monitoring. The failure to adequately identification and detect plant pathogens using traditional, culture based morphological strategies has led to the development of nucleic acid based molecular approaches. Molecular diagnostic began to develop a real momentum after the introduction of polymerase chain reaction (PCR) within the mid-1980s. To date, an increasing number of agricultural research and studies center is adapting molecular techniques for habitual detection of pathogens. With the advances in molecular biology and biosystematics, the strategies to be had have developed significantly inside the final decade, and besides conventional PCR other technologically superior methodologies along with the real time PCR and microarrays which allows limitless multiplexing functionality have the ability to carry pathogen detection to a brand new and improved stage of efficiency and reliability.

## *Detection of specificity and sensitivity*

Sensitivity and specificity are numeric measures of effectiveness of a detection system. Diagnostic specificity is described as a measure of degree to which the technique is stricken by non-target components present in a sample, which may bring about false positive responses. Diagnostic sensitivity is described as a degree to hit upon the target pathogen within the sample, which may bring about false negative responses. Thus, a high degree of diagnostic accuracy is characterized by means of the ability to discover, real and precisely the target microorganism from a sample without interference from non-target components. The high degree of sensitivity of molecular methods made pre-symptomatic detection and quantification of pathogens possible. One of the most important advantages that molecular based detection has over conventional diagnostic detection strategies is the high specificity. That is the capacity to distinguish intently related organisms.

The specificity of PCR, be it conventional or real-time, relies upon the designing of proper PCR primers which are unique to the goal organism. Highly conserved gene areas are frequently the target for designing primers. Closely associated microbial species regularly range in a single-nucleotide polymorphism (SNPs) to few bases in such genes. A wide variety of inhibitors are reported. Although their mode of action isn't always clear, those inhibitors are believed to interfere with the polymerase activity for amplification of the target DNA.

## *Determination of viability*

Nucleic acid-based detection techniques currently carried out in pathogen detection are based on nucleic acid hybridization or PCR. These strategies may be designed to hit upon both DNA and mRNA. Whereas DNA based detection approach is frequently more straightforward than that of mRNA, the steadiness of DNA ends in the opportunity that DNA based methods yield superb results from non-possible or dead pathogens. One of the main goals of pathogen detection system, besides figuring out the presence and lack of the pathogen, is the viability since in the occasion of fine result, it is crucial to recognize whether the pathogen detected poses chance to crop production, public health or food safety. In order to circumvent this problem many studies consider enrichment culturing (BIO PCR) instead of direct PCR. While the system allows the detection of best viable cells and facilitates in removal of feasible PCR inhibitors, it isn't appropriate approach for quantitative assay.

***Pathogen quantification***

Quantification of a pathogen upon its detection and identification is an important component as it could be used to estimate its ability risk regarding disorder development, establishment and unfold of inoculum and monetary loss. In addition, it provides statistics for well-informed disease control decisions. PCR is good for detection of small quantity of the target. Three PCR variants namely restriction dilution PCR, kinetic PCR and competitive PCR were used for quantitative evaluation of DNA. However, all are based on end point measurements of the amount of DNA produced which makes estimation of initial concentration of DNA and quantification rather problematic. A low abundance target with excessive genetic similarity to a microarray probe might produce a more potent hybridization signal in comparison with a higher abundance goal that has low similarity to the equal microarray probe. Due to the advancement of fluorogenic chemistry, a second generation PCR known as real time PCR has come to be a rising approach for the detection and quantification of microorganisms within the environment.

In PCR the target DNA sequence is amplified over a number of denaturation-annealing-extension cycles. In a conventional PCR, handiest the very last concentration of the amplicons can be monitored the use of a DNA binding fluorescent dye. However, in the quantitative real time PCR, the concentration of the amplicons is monitored at some point of the amplification cycles by the use of a collection of fluorescent reagents. The fluorescence intensity emitted during this procedure displays the amplicons concentration in real time.

***Multiplexing***

Crops may be infected with the aid of several pathogens and they'll be present in plant life in complexes. Therefore, it is important to develop appropriate technology that may detect multiple pathogens simultaneously. Multiplex PCR, a PCR variant that is designed to amplify multiple targets by means of the usage of multiple primer sets within the equal reaction, has been applied in lots of tests. Multiplex PCR assays can be tedious and time ingesting to establish and generally requiring lengthy processes. Among the drawbacks of such variation PCR assays are that the sensitivity is decreased notably and the number of different targets to be amplified in one assay is limited.

Moreover, the dynamic variety of the target in the sample to be tested isn't continually reflected in the final results of the test. The real-time PCR offers better multiplexing opportunities; however, multiplexing remains limited via the supply of dyes emitting fluorescence at extraordinary wavelengths. Thus, detection of extra than few pathogens is currently now not possible, by the use of these systems. In the beginning, DNA microarray was designed to look at gene expression and generate single nucleotide polymorphism (SNP) profiles and it is currently a brand new and emerging pathogen diagnostic technology which in theory, gives a platform for limitless multiplexing functionality. The principle of microarray is the hybridization of fluorescently labelled sequences or goals to their complementary sequences spotted on strong surface, including glass slides, serving as probes. The unlimited functionality for simultaneous detection of pathogens makes microarrays to be a method with a potential capability of detecting all applicable pathogens of a specific crop. In plant pathology, the technique was carried out for figuring out oomycete, nematode, bacterial and fungal DNA from pure cultures.

***Conclusion and future outlook***

Currently more and more research centre and laboratories are using molecular methods for detection and identification of pathogens. The development of more versatile robust and cost-effective systems, allowing for greater sensitivity and specificity, elevated throughput and detection of multiple microbes will continue over the coming years. Pathogen detection is only the first step; quantification and isolate characterization are crucial elements in diagnostics. Diagnostic technology is moving from qualitative to quantitative and there is no doubt that most tests will be quantitative in the future. Microarray-based technology is the most suitable technique for multiple pathogen detection in a single assay. Currently microarrays can be expensive for routine application. However, with reducing fabrication costs, the cost per sample will be significantly lower. The effort to add a quantitative aspect to microarrays must continue and more work is needed to address the challenges of working on environmental samples where contaminants (humic matter, organic substances, heavy metals etc.) may interfere with DNA hybridization and affect the performance of microarrays. Adding innovative molecular tools for differentiating viable from non-viable organisms should be given emphasis in developing diagnostic assays.

However, while the specificity and sensitivity of detection of pathogens are greatly progressed and pathogen detection is becoming simpler and faster, there are still important challenges, technical and economic nature, which want to be addressed to ensure the emergence of reliable detection machine for routine applications. Pathogen detection is simplest the first step; quantification and isolate characterization are crucial factors in diagnostics. Diagnostic generation is shifting from qualitative to quantitative and there may be absolute confidence that most tests might be quantitative within the future. Microarray-based era is the maximum suitable approach for a couple of pathogen detection in a single assay. Adding revolutionary molecular tools for differentiating viable from non-viable organisms should accept emphasis in developing diagnostic assays.

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# Real Time Nitrogen Management Under SSNM

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## *Introduction*

Nitrogen is the most important nutrient for plant growth, yield, quality and environment. It is an essential component of amino acids, auxins, cytokinins, proteins, alkaloids, glucosinolates and various other food components. Adequate amount of nitrogen is required to support photosynthesis, since it is an integral part of chlorophyll molecuele. Crop plants can obtain much of their required N from the soil and organic sources, but the supply of N from these sources is seldom sufficient for supporting crop yield. Supplemental N from fertilizers is essential for higher yields and profit under field conditions.

Site Specific Nutrient Management is an approach for supplying the crop with nutrients at right time, right amount, right place and right manner. It aims at optimal use of nutrients by the crop from indigenous sources (soil, crop residue, manure, and irrigation water) and timely application of fertilizers at optimum doses. Feeding of crops with nutrients is done as and when needed by the crop. The goal of SSNM is to match nutrient supply from various sources with crop requirement and minimize nutrient losses from fields. For best effect, nutrients should be applied during the growing season to ensure that nutrients supply matches with the crop need at the critical growth stages.

## *What is real time nitrogen management*?

Nitrogen can be lost from the soil plant system by leaching, runoff, denitrification or volatilization. The reason is that, there is lack of synchrony of plant nitrogen demand with nitrogen supply. An important part of SSNM is use of tools that can assess real N needs of crop plants. It can help us to apply N at optimum doses and achieve high nutrient use efficiency.

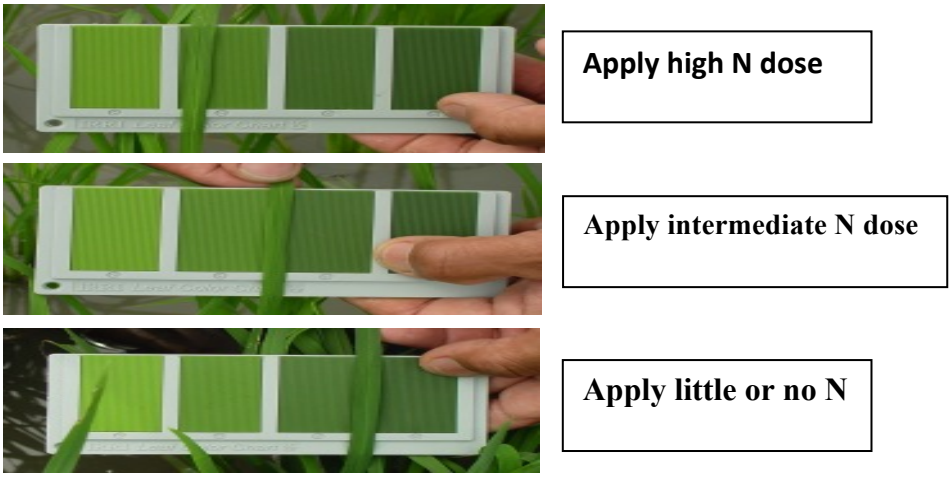
The various tools which are used for real time nitrogen management includes leaf colour chart, chlorophyll meter, optical sensors, remote sensing or use of GIS. The most commonly used tools are –

### 1. *Leaf colour chart method*

The Leaf Colour Chart (LCC) is used to determine the N fertilizer needs of rice crops. It was developed by International Rice Research Institute for N management in rice. LCC has four panels with colour ranging from yellow green to dark green. It determines the greenness of the rice leaf which in turn indicates its N content.

We use LCC by randomly selecting at least 10 disease free rice plants or hills in a field with uniform plant population. Then, select the topmost fully expanded leaf from each hill or plant and place the middle part of the leaf on a chart and compare the leaf colour with the colour panels of the LCC. Do not detach or destroy the leaf. If it is possible the same person should take LCC readings at the same time of the day every time. LCC can be used to

determine amount and timing of N fertilizer application in rice, wheat, maize and other crops. It is cheap and can easily be adopted by farmers.




**(Source: Fairhurst & Witt, 2002. Rice: A practical guide to nutrient management)**

**Fig.1:** Using the leaf colour chart (LCC) under field conditions

## 2. *Chlorophyll meter or SPAD meter*

Chlorophyll meter or SPAD (Subsystem Positioning Aid Device) is used by researchers to estimate N status of crops. It works by emitting two frequencies of light, one at a wavelength of 660 nm (red) and one at 940 nm (infrared). Leaf chlorophyll absorbs red light but not infrared and the difference in absorption is measured by the meter and termed as "Optical Density Difference," i.e. ODD. ODD indicates the ratio of reflection vs. absorption. It can measure relative difference in crop N status and is also able to detect the onset of N stress before it is visible. Generally when SPAD value is less than the set critical reading than accordingly N fertilizer is applied.


**(Source: Chlorophyll meter SPAD 502 plus, Indiamart.com)**

**Fig. 2:** Use of Chlorophyll meter under field conditions

## 3. Green Seeker sensor

It is an integrated optical sensing and application system that measures crop status and variably applies the crop's nitrogen requirements. Yield potential for a crop is identified using a vegetative index known as NDVI (Normalized Differential Vegetative Index). The sensor uses light emitting diodes (LED) to emit light in two wavelengths i.e. red and near infrared

(NIR) light. The reflectance from the crop canopy is measured by a photodiode located at the front of the sensor head and calculates Normalized Differential Vegetative Index.

$$NDVI = \frac{\text{F NIR} - \text{F RED}}{\text{F NIR} + \text{F RED}}$$

NDVI value is related to the amount of plant material in the field and its greenness.

Where,

F NIR = Fraction of emitted near IR radiations reflected back from the sensed area

F RED = Fraction of emitted red radiations reflected back from the sensed area.


**(Source: Handheld Green seeker, vantage–ro.com)**

**Fig. 3:** Use of green seeker under field conditions

***Conclusion***

Site Specific Nutrient Management helps in saving of inputs, increase in fertilizer and other input use efficiency, aims at uniform crop stand with more yields and also ensures balanced application of fertilizers. Real time N management helps to estimate N status of plant and is used to improve N management by estimating the need of the crop for fertilizer before sowing and by distributing the fertilizer during the cropping season based on crop need. It also helps in maintaining the nutrient balance of the soil and minimising the nutrient losses. In addition, these nitrogen management practices have the ability to reduce agricultural non-point source pollution and to enhance economically sustainable crop production.

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# Can Green Buildings Really Help Combat Climate Change?

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Article ID: 38

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## *Introduction*

Smart cities are becoming increasingly important to combat the global climate change crisis. They are uniquely positioned to tackle numerous sustainability tactics, ranging from greener commercial buildings to electrifying public transit, using the Internet of Things (IoT) to connect and better understand the major contributors to carbon emissions. In urban areas, the impact on the environment is markedly different than in rural areas (Abdoullaev, 2011). People in urban environments consume much more food and goods than rural populations. They also own more cars per capita and use more energy. Increased energy consumption creates heat islands in some places that contribute to changing local temperatures and weather patterns. At a micro level, buildings in cities consume a huge portion of primary energy and electricity, which is significant because the process of making energy is one of the largest sources of greenhouse gas (GHG) emissions worldwide (Von Weizsacker *et. al.,* 2009). Despite these challenges, action is being taken at every level of society to combat climate change. One of these changes is taking place at the micro level inside the four walls of what are known as "green buildings."

## *Green building*

A green building is a building that's designed with the health and wellbeing of both its occupants and the environment in mind. Everything about a green building, like how it's constructed, operated and maintained, aims to minimize its impact on the environment and provide a healthy work environment (Kibert,2016).

## *Features of green building*

- Reducing water and energy consumption
- Minimizing greenhouse gas emissions
- Using eco-friendly building materials
- Decreasing landfill waste
- Being located thoughtfully to shrink commute times
- Encouraging renewable transportation use
- Encouraging IoT connectivity
- Enhancing the natural environment with trees, green roofs or community gardens

Not only do green buildings reduce negative impacts on the environment, but they also save money on operating costs, especially over the long run. By enabling IoT technology,

building occupants who value the health and wellbeing of our planet have an opportunity to contribute to energy savings and reduce their carbon footprint (Kibert,2016).

***LEED (Leadership in Energy and Environmental Design)***

Green buildings can be certified using LEED, the most commonly used green building rating system in the world (Council, 2008). There are several different levels of LEED certification, depending on the credits a building achieves above and beyond the basic certification requirements. Regardless of the level it reaches, LEED-certified buildings are widely recognized as buildings that save energy, water and resources and generate less waste and support human health.

***Green Buildings Help to Combat Climate Change***

Green buildings work to slow down the effects of climate change in two main ways. First, they are more energy-efficient. Energy efficiency can be accomplished by conducting retrofits, optimizing operations, IoT connectivity, adding solar or renewable energy onsite or taking advantage of existing landscape features like shade. In fact, by focusing on energy efficiency measures, new buildings can often reduce their energy consumption by up to 25 percent and old buildings by up to 16 percent (Darko *et al* 2017). Furthermore, by 2040, changes to space heating, water heating and water cooling could see buildings become nearly 40 percent more efficient than they are today.

Second, green buildings can help to promote green communities. Smart city agendas globally have placed a great deal of importance on sustainability and creating greener and healthier cities for their citizens. Green communities take into account the many facets of the built environment and try to lessen their impact on the environment together (Chan *et. al.,* 2017). This includes increasing access to cleaner transportation or walking / cycling, reducing water usage, enhancing green spaces and carefully planning cities and communities to minimize disruption to the environment. Green buildings, when situated inside green communities, can maximize their impact and contribute to an overall societal shift towards a healthier tomorrow.

***Conclusion***

Green buildings have become increasingly popular and important in the last several decades. As more occupants look for spaces that are good for both people and the environment, and as the pressures to slow and reverse climate change heats up, green buildings are here to stay. There are many opportunities to "green" both old and new buildings, especially with IoT technology becoming more mainstream. Sometimes these changes are major and involve deep retrofits. Other times, they require more actions to optimize workflows, people, processes and things. Regardless, greening a building benefits everyone: the occupants, the environment and the owner/operators' bottom line.

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# Principles of Irrigation Scheduling of Crop

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## *Introduction*

Irrigation scheduling is the process used by irrigation system managers to determine the correct frequency and duration of watering, correct amount of time in which water or labor may be available for irrigation. Irrigation scheduling can be defined as "the process of determining when to irrigate and how much water to apply, based upon measurements or estimates of soil water or water used by the plant"**.** Scheduling irrigation is very critical for obtaining optimal crop yields. For optimum irrigation scheduling, sound knowledge of the soil water status, crop water requirements, crop water stress status, and potential yield reduction under water-stressed conditions is prerequisite to maximize profits and optimize the use of water and energy.

## *The factors may be taken into consideration:*

- ***Precipitation rate of the irrigation equipment*** – how quickly the water is applied, often expressed in inches or mm per hour.
- ***Distribution uniformity of the irrigation system*** – how uniformly the water is applied, expressed as a percentage, the higher the number, the more uniform.
- ***Soil infiltration rate*** – how quickly the water is absorbed by the soil, the rate of which also decreases as the soil becomes wetter, also often expressed in inches or mm per hour.
- ***Slope (topography) of the land*** being irrigated as this affects how quickly runoff occurs, often expressed as a percentage, i.e. distance of fall divided by 100 units of horizontal distance (1 ft of fall per 100 ft (30 m) would be 1%).
- ***Soil available water capacity*** expressed in units of water per unit of soil, i.e. inches of water per foot of soil.
- ***Effective rooting depth*** of the plants to be watered, which affects how much water can be stored in the soil and made available to the plants.
- ***Current watering requirements*** of the plant (which may be estimated by calculating evapotranspiration (ET), often expressed in inches per day.
- Amount of time in which water or labor may be available for irrigation.
- Amount of allowable moisture stress which may be placed on the plant. For high value vegetable crops, this may mean no allowable stress, while for a lawn some stress would be allowable, since the goal would not be to maximize production, but merely to keep the lawn green and healthy.
- Timing to take advantage of projected rainfall

- Timing to take advantage of favorable utility rates
- Timing to avoid interfering with other activities such as sporting events, holidays, lawn maintenance, or crop harvesting.

The goal in irrigation scheduling is to apply enough water to fully wet the plant's root zone while minimizing overwatering and then allows the soil to dry out in between watering, to allow air to enter the soil and encourage root development, but not so much that the plant is stressed beyond what is allowable.

***The basic principles of irrigation scheduling from a soil-water view are*:**

***1. Soil moisture***

Sites for monitoring soil moisture should be chosen to be most representative of the field. The purpose is to limit under-watering of the heavier soils and over-watering lighter soils. For precision irrigation where watering can be controlled in smaller areas within the field, more monitors would be needed and both better and poorer soils would need to be monitored.

***2. Root zone depth***

Root zone depth is the zone where most of the root structure is found. The irrigation technique known as partial root-zone drying has proved to hold the potential to increase water use efficiency without significantly reducing yields. The technique essentially involves irrigating approximately half of the root system of a crop while the other half is left to dry.

***3. Water holding parameters***

Two measurements would be important. The "fill point" is the wettest a soil can be before water drains below the root zone. This would be near 100% field capacity (FC) or 100% holding capacity of the root zone and depends on soil texture. In general, sandy soils have the lowest FC while silt loams have the highest with clays being intermediate. The "refill point" is the driest a soil can be before daily water use is lowered due to too little water in the root zone. This begins to induce the shutting of stomata's resulting in reduction of carbohydrate synthesis (photosynthesis) and respiration (metabolism), and leads to wilting. This has a direct relation to yield. The difference between field capacity and 40% depreciation is the "allowable depletion" (AD) amount of water and, for potato, is 20-25% FC or about half the total available water (about 40% FC). In sandy loam soils, the AD is three-quarters to one-inch water up to a depth of 12 inches or one to one and a half inch for the root zone (Curwen and Massie, 1994; Yonts and Klocke, 1985). Soils that are compacted or tend to seal will lower water-holding capacity and reduce penetration of water into the soil.

***4. Effective irrigation***

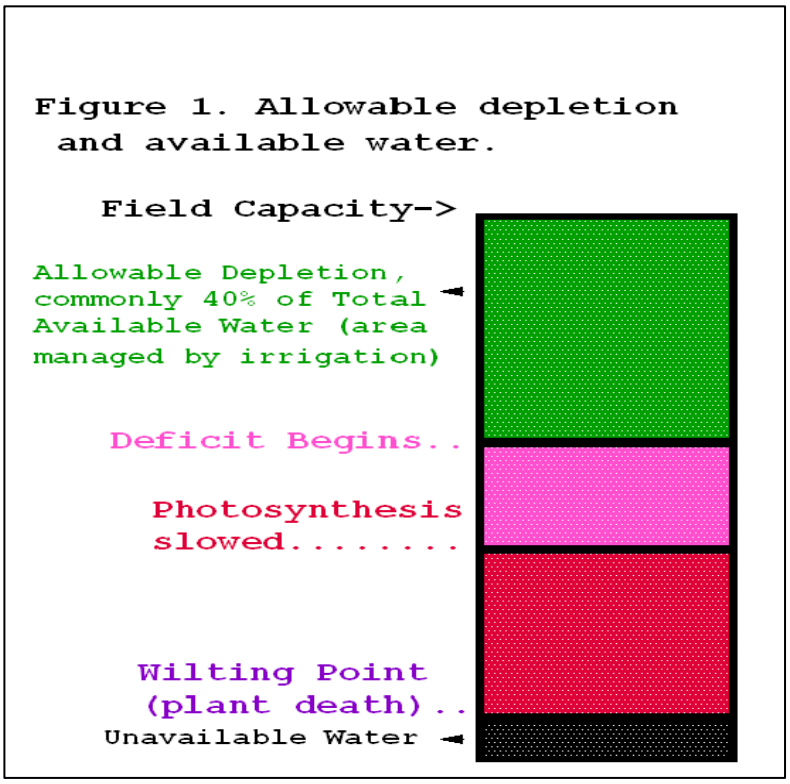
Effective irrigation is the amount of water that actually gets into the root zone and is available to the plant. Some of the irrigation water (actual irrigation) is lost as run-off, evaporation or deep percolation.

***5. Daily water use***

Daily water usage by the crop is dependent on the growth stage of the plant and environmental conditions on that day. It is directly related to canopy development, mostly leaves which contain nearly all the stomata. Environmental conditions that affect daily water use are air temperature, relative humidity, wind, and solar radiation. An excellent guide to daily water usage is evapotranspiration (ET) data that is calculated from weather station data (Klocke et al., 1990). ET is the total daily water use from both transpiration by the plant and evaporation from the soil.

***In summary, the key factors in managing irrigation are:***

- How much water gets into the soil?
- How much water the soil can hold?
- How much water is being used by the plant?

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# Nutrient Management – a crucial factor for crop production with higher productivity for food security

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**Introduction:**

It is the science and practice directed to link soil, crop, weather, and hydrologic factors with cultural, irrigation, and soil and water conservation practices to achieve optimal nutrient use efficiency, crop yields, crop quality, and economic returns, while reducing off-site transport of nutrients.It involves matching a specific field soil, climate, and crop management conditions to rate, source, timing, and place (commonly known as the 4R nutrient stewardship) of nutrient application.

**Nutrient management is important for the following facts**:

1. Nutrient management helps to reduce contamination to waterways by plant nutrients.
2. Improve the soil fertility.
3. Enhance the plant productivity.
4. Reduce the cost of chemical fertilizers.
5. Providing balanced nutrition to crops.
6. Promotes carbon sequestration and prevents the deterioration of soil, water, ecology, and also leaching of nutrients from the soil.

**Important parameter for nutrient management**

**Fertilizer type**: Important considerations are ratio of ammonium to nitrate-N, trace element charge, content of calcium and magnesium, and potential acidity or basicity. Ideally no more than 50 percent of the total nitrogen supplied to plants grown in soilless media should be in the ammonium form. Ammonium toxicity can occur in soilless media due to high levels of ammonium or urea fertilizer. The toxicity occurs on some plants when the soil is cool and waterlogged, when the ammonium is converted to ammonia.

**Fertilizer rate**: Traditionally fertilizer rate (ppm) has been the main focus of greenhouse fertilizer programs, but rate interacts with the other five factors on this list to determine the success of a fertility program.

**Frequency of application**: How many times water-soluble fertilizer is applied is often overlooked as a factor in developing a good fertilizer program. What does the term "constant

liquid feed" (CLF) really mean - every watering, once a week, or twice a week? At a given ppm level, more frequent applications will lead to a higher fertility level simply because fertilizer is applied more often.

**Volume of fertilizer solution applied**: As the volume of water-soluble fertilizer increases the quantity of nutrients delivered to the plant also increases. Doubling the volume applied also doubles the amount of each nutrient potentially available to the plant.

**Leaching fraction**: Leaching fraction is the proportion of fertilizer solution or irrigation water applied that is lost from the plant container by leaching. The lower the leaching fraction, the greater the quantity of nutrients and salts retained in the growth medium. Leaching fraction is strongly affected by volume applied (i.e., factor 4). Avoiding excess leaching is critical to reducing both fertilizer costs and ground water contamination.

**Plant growth rate and environmental conditions**: In general, nutrient requirements of greenhouse crops are greatest during periods of rapid growth. Two major influences on growth rate are the inherent growth pattern followed by the plant and the environment in which it is grown. Too much fertilizer during slow growth periods may lead to excess soluble salts; failure to provide enough fertilizer during periods of rapid growth will lead to deficiency.

**Potential Acidity and Basicity of Greenhouse Fertilizers**

Fertilizers may raise or lower the pH of the growth medium. Fertilizers are rated as to their potential acidity or potential basicity. This value is determined largely by the amount and sources of nitrogen in a formula. Fertilizers that contain more urea and ammonical nitrogen are acidic in reaction, while those that contain primarily nitrate nitrogen are basic. The numbers used to express these potentials refer to the pounds of limestone (calcium carbonate) that it takes to either neutralize (potential acidity) or be equivalent in reaction to (potential basicity) on ton of that fertilizer. In theory, by alternating fertilizers, the medium pH should be able to be stabilized. In reality, the pH of the medium is a dynamic system and is influenced by many other factors such as irrigation water alkalinity, fungicide drenches and root exudates

**Important nutrient management strategies**

**General Plant Nutrition**

The 16 elements required by all plants are carbon (C), hydrogen (H), oxygen (O), phosphorus (P), potassium (K), nitrogen (N), sulfur (S), calcium (Ca), magnesium (Mg), iron (Fe), boron (B), manganese (Mn), copper (Cu), zinc (Zn), molybdenum (Mo), and chlorine (Cl).The elements C, H, and O are supplied largely from air (carbon dioxide ($CO_2$) and oxygen), and water ($H_2O$). The nutrients N, P, K, S, Ca, and Mg are referred to as the macronutrients because they are required in larger quantities by the plant compared to the remaining elements. The other seven elements are referred to as micronutrients because they are required in small amounts, usually a few parts per million (ppm) in the plant tissue.

**Phosphorus** is absorbed as $H_2PO_4^{-1}$ or $HPO_4^{-2}$ by an active energy-requiring process. P is very mobile in the plant. Deficiencies therefore show up on the older leaves of the plant because P is translocated out of these leaves to satisfy needs in the new growth. P deficiency

shows up as stunting and a reddish coloration resulting from enhanced levels of anthocyanin pigments. Deficient leaves will have only about 0.1% P by dry matter. Normal most-recently-matured leaves of most vegetables will contain 0.25 to 0.6% P on a dry weight basis

**Potassium** is absorbed in large quantities by an active uptake process. Once in the plant, K is very mobile and is transported to young tissues rapidly. Deficiency symptoms for K show up first on lower leaves as a marginal flecking or mottling. Prolonged deficiency results in necrosis along the leaf margins and the plants can become slightly wilted. Deficient plant leaves usually contain less than 1.5% K.

**Nitrogen** can be absorbed by the plant in either the nitrate ($NO_3$) or ammonium ($NH_4^+$) forms. The $NO_3$ form is usually the preferred form in which to supply most N to greenhouse crops. The $NH_4$ form seems to be absorbed easier than $NO_3$ at cool temperatures (less than 55F). Uptake of $NH_4$is best at a media pH near neutrality with uptake reduced as pH is dropped.

**Sulfur** is absorbed mainly in the form of sulfate ($SO_4$). Sulfur is not very mobile in the plant so deficiency generally begins in the new growth. Deficiency symptoms consist of a general yellowing of the leaves. Deficiencies of N and S appear similar but N deficiency occurs on the lower leaves; S deficiency occurs on the upper leaves.

**Calcium**, unlike most elements, is absorbed and transported by a passive mechanism. The transpiration process of the plants is a large factor in the uptake of Ca. Once in the plant, calcium moves toward areas of high transpiration rate such as the rapidly expanding leaves.

.**Magnesium** is absorbed by the plant in lower quantities than Ca. The absorption of Mg is also highly affected by competing ions such as K, Ca, or $NH_4$. Unlike Ca, Mg is mobile in the plant and deficiencies appear first on the lower leaves.Mg is usually found in concentrations of 0.2% to 0.8% in normal leaves. Conditions that lead to deficiency include poorly designed fertilizer programs that supply too little Mg or ones that supply excess K, Ca, or $NH_4$.

**Iron** can be absorbed by an active process as $Fe^{2+}$ or from iron chelates which are organic molecules containing iron sequestered within the molecule. Uptake of iron is highly dependent on the iron form and adequate uptake depends on the ability of the root to reduce

**Manganese** is absorbed as $Mn^{2+}$ ions and the uptake is affected by other cations such as Ca and Mg. Manganese is relatively immobile in the plant and symptoms of deficiency show up on the upper leaves. Deficiency of Mn resembles that of Mg, however, Mg appears on the lower leaves of the plant. Mn deficiency consists of interveinal chlorosis; however the chlorosis is more speckled in appearance compared to magnesium deficiency. Normal concentrations of Mn in leaves ranges from 30 ppm to 125 ppm for most plants. High concentrations of Mn can be toxic to plants. Toxicity consists of marginal leaf necrosis in many plants. Concentrations of Mn on the order of 800 ppm to 1000 ppm can lead to toxicity in many crops. Excess Mn in the nutrient solution reduces uptake of Fe.

**Zinc** uptake is thought to be by an active process and can be affected by concentration of P in the media. Zn is not highly mobile in plants. Deficiency of Zn results in leaves with interveinal chlorosis. Sometimes Zn deficiency will lead to plants with shortened internodes. Normal leaves contain about 25 ppm to 50 ppm Zn. High concentrations of Zn can lead to toxicity where root growth is reduced and leaves are small and chlorotic. Zinc deficiency can

be increased by cold, wet growing media or by media with a very high pH or with excessive P.

**Copper** is absorbed by plants in very small quantities. The uptake process appears to be an active process and it is strongly affected by Zn and pH. Copper (Cu) is not highly mobile in plants but some Cu can be translocated from older to newer leaves. The normal level of Cu in plants is on the order of 5 to 20 ppm.Copper deficiency of young leaves leads to chlorosis and some elongation of the leaves. Excess copper, especially in acidic media, can be toxic.

**Molybdenum** is absorbed as molybdate $MoO_4^{2-}$ and the uptake can be suppressed by sulfate. Tissue contents of Mo are usually less than 1 ppm.A deficiency of Mo first appears in the mid leaves and the older leaves. The leaves become chlorotic and the margins roll. Unlike other micronutrients, Mo deficiency occurs mostly under acidic conditions.

**Boron** uptake by plants is not well understood. Boron (B) is not mobile in the plant and seems to have many uptake and transport features in common with Ca.Boron deficiency affects the young growing points first, e.g., buds, leaf tips, and margins. Buds develop necrotic areas and leaf tips become chlorotic and eventually die. Tomato leaves and stems become brittle. Normal leaves contain 20 ppm to 40 ppm B while high levels may lead to toxicity. **Chlorine** deficiency is very rarely observed in crop plants. This is because Cl is needed in very small amounts and Cl is present in the environment in the fertilizers, water, air, and media.

**Conclusion**:

It is here by conclude that the nutrient management is very much crucial important factor for crop production with higher productivity so there for proper nutrient source with good physical condition material are applied for higher productivity in crop production and govt imitative with subsidy are considerable factor also farmer awareness programme .

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# DNA Replication in prokaryotes

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The prokaryotic chromosome is a circular molecule with a less extensive coiling structure than eukaryotic chromosomes. The origin of replication is approximately 245 base pairs long and is rich in AT sequences. This sequence of base pairs is recognized by certain proteins that bind to this site. An enzyme called **helicase** unwinds the DNA by breaking the hydrogen bonds between the nitrogenous base pairs. As the DNA opens up, Y-shaped structures called **replication forks** are formed. Two replication forks are formed at the origin of replication and these get extended bi-directionally as replication proceeds. The next important enzyme is **DNA polymerase III** also known as DNA pol III, which adds nucleotides one by one to the growing DNA chain. In prokaryotes, three main types of polymerases are known: DNA pol I, DNA pol II, and DNA pol III. DNA pol III is the enzyme required for DNA synthesis; DNA pol I is used later in the process and DNA pol II is used primarily required for repairing. DNA polymerase is able to add nucleotides only in the 5′ to 3′ direction (a new DNA strand can be only extended in this direction). Another enzyme, **RNA primase**, synthesizes an RNA primer that is about five to ten nucleotides long and complementary to the DNA. DNA polymerase can now extend this RNA primer, adding nucleotides one by one that are complementary to the template strand. The replication fork moves at the rate of 1000 nucleotides per second. DNA polymerase can only extend in the 5′ to 3′ direction. This continuously synthesized strand is known as the **leading strand**. The other strand, complementary to the 5′ to 3′ parental DNA, is extended away from the replication fork, in small fragments known as **Okazaki fragments**, each requiring a primer to start the synthesis. The strand with the Okazaki fragments is known as the **lagging strand**. The leading strand can be extended by one primer alone, whereas the lagging strand needs a new primer for each of the short Okazaki fragments. The overall direction of the lagging strand will be 3′ to 5′, and that of the leading strand 5′ to 3′. As synthesis proceeds, the RNA primers are replaced by DNA pol I, which breaks down the RNA and fills the gaps with DNA nucleotides. The gaps that remain between the newly synthesized DNA (that replaced the RNA primer) and the previously synthesized DNA are sealed by the enzyme **DNA ligase.**

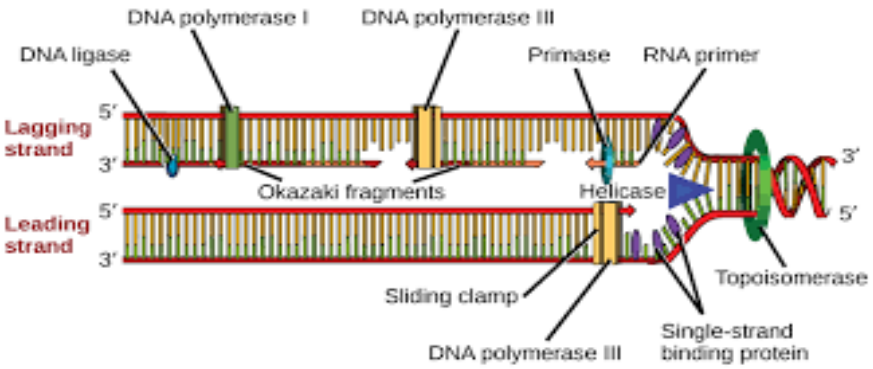


**Fig: DNA replication in prokaryotes**

# Role of Plant Quarantine in Disease Management

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## Introduction:

Plant diseases have in many cases caused significant losses to humans.The famine caused by potato late blight (*Phytophthora infestans*) caused starvation and uprooting of households. The virtual extinction of American chestnut by chestnut blight (*Cryphonectria parasitica*) and the direct economic loss ($1 billion) occurred in one year to American corn growers from southern corn leaf blight (*Cochliobolus maydis* and *Anamorph Bipolaris maydis*) lost a valued resource. Most plant diseases cause less drastic losses annually across the globe but collectively represent major losses for farmers. Most methods, approaches, and procedures used in the management of diseases may be grouped under one or more very specific concepts.

The first principle (prevention) requires pre-infection disease control strategies ( i.e. the plant is protected from disease), the second principle (therapy or curative action) works with any treatment introduced following infection of the plant (i.e. the plant is treated for the disease). An example of the first concept is quarantine compliance to avoid the introduction of a disease agent (pathogen) into a area where it is not present. Quarantines In recent years , the quantity of import and export of plant commodities has increased, and there is a distinct possibility of moving insect pests and diseases from their original native dwelling to new location. Legal restrictions are imposed generally known as Quarantine to avoid the introduction of alien pests , diseases, and weeds from foreign countries or within the nation.

## Plant quarantine

Regulatory steps for plant quarantine are taken at national (Domestic Quarantine) and international (Foreign Quarantine) level. Legal enactments support the implementation of the quarantine measures, called quarantine laws. The Successful quarantine implementation for pest control is strongly emphasised, which in turn helps to preserve crop productivity. Analysis of the pest risk in the introduction of plants is important for determining whether or not a specific planting material should be permitted to enter. A material's attitude to the 'entry status' may be liberal or conservative, depending on the risks involved in its implementation. If the risks are small it would be liberal to allow quarantine to enter.

However, the content can be refused entry when the risks are very high. Factors such as the availability of skilled staff, successful identification methods, point-of-entry quarantine procedures, knowledge of the life cycle of the species, the nature of races and strains, world distribution, modes of transmission, disease / pathogens establishment and spread factors, and

the availability of precautions should also be taken into account. Examination of Domestic Quarantine Regulations Regulatory legislation to avoid the introduction and spread of harmful crop pests are operational through the "Insect and Pest Harmful Act, 1914"The central government operates the domestic quarantine regulations through powers conferred under section 4A, B & D and section 5 authorizes the state government to enact similar regulations and section 5A provides for the penalties. In 1944, central government released the first domestic quarantine notification against fluted scale (*Icerya purchasi*) and in 1953, the scale of San Jose (*Quadraspidiotus perniciosus*).

A new plant Quarantine Order (PQ Order) was notified by the Government of India in 2003 to harmonize India's regulatory system with the International Plant Protection Convention (IPPC) and the internationally agreed standard and the World Trade Organization ( WTO) SPS Agreement principles. Cotton cushion scale, woolly aphid, San Jose scale, golden cyst potato nematode, the giant African snail are some exotic plague introduced into India and inflict significant damage before the PQ Order 2003.The spread of banana bunchy top virus disease from Assam, Kerala, Orissa and Tamil Nadu . In 1959 the central government released a notification against potato wart (*Synchytrium endobioticum*), which banned the movement of potato from West Bengal states. In 1977, central government released a notification banning the export of apple planting materials from Himachal Pradesh to prevent the spread of apple scab (Venturia inequalis) from state Himachal Pradesh. Overall, threats are greater with adding vegetative propagules than with true seed. Also, pathogens such as viruses, downy mildews, smuts and other bacteria borne within the seed without any visible symptoms pose much greater threats.

When introducing vegetative propagules, rooted plants, and other underground parts of plants such as rhizomes, suckers, runners, etc. Bring higher risks than wood in the bud, sawdust and unrooted cuttings. In either case, bulk introductions are often risky because rigorous inspection and treatment is very difficult in these cases and the area of planting is much too large to prevent the establishment and spread of the introduced pest / disease. Based on these factors, the introduction is governed by plant quarantine as follows: full embargo / prohibition, quarantine postentry, restricted and unrestricted.

**Agencies involved in Plant Quarantine in India**

Presently there are total 26 different quarantine stations located at 10 Airports (Amritsar, Mumbai, Kolkata, Hyderabad, Chennai, New Delhi, Patna, Tiruchirapally, Trivandrum, Varanasi), 9 at Seaports (Bhavnagar, Mumbai, Kolkata, Cochin, Nagapatnam, Rameshwaram, Tuticorin, Vishakapattnam) and 7 at Land Frontiers (Amritsar railway station, AttariWagha Border, Attari-Raiway station, BongaonBenapol border, Gede Road railway station, Panitanki, Kalimpong). Inspection procedures at quarantine station Visual inspection, X-ray testing, washing test, sedimentation testing, incubation testing, test growth, serological methods: (a) ELISA (Enzyme Linked Immuno-sorbant Assay) (b) DIBA (Dot Immuno-binding Assay) (c) ISEM (Immunosorbant Electron Micro Scopy) (d) Latex agglutination test, Nucleic acid hybridization and Polymarised chain reaction (PCR).

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# Role of Insect Polinators in crop production

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**Pollination Introduction:**

Pollination is refers to the transfer of anther to stigma in flowering plants for sexual reproduction. This helps to bring about fertilization of the ovules in the flower by the male gametes from the pollen grains. Approximately, 80 percent of all flowering plants species are pollinated by animals, including vertebrates and mammals. Among these insect are the but the main pollinators are insects. Entomophily is refers to cross pollinated aided by insects.

**Insect pollination:**

Pollinators are responsible for providing with a wide variety of orchard, agricultural crops, horticultural crops and forage production. More than three quarters of the world's food crops rely at least on some parts on pollination by insects and other animals. In India, about 80 percent or more of the crop plants depend or stand benefited from insect pollination. About 750 to 1000 bee floral plants estimated to be growing in India. Of the 160 million hectares of the cropped area, more than 55 million is under bee dependent crops. Insect pollinators include honey bees, bumble bees, pollen wasps, ants, flies including bee flies, hoverflies and mosquitoes, butterflies and moths and flower beetles. 50 percent of the plant species propagated by seeds are dependent on insect pollination whereas one third of the food supply is either directly or indirectly depend on these insects pollinated plants. Many insect pollinated crops are high yielding, nutritious and of high economic value. Several insect pollinated crops also form an important income source in developing countries like production of coffee and cocoa. Cocoa beans used for the production of chocolate are pollinated by midges. Similarly, mango flowers are pollinated by wide variety of insects such as wasps, ants, flies, butterflies, beetles and bees. Among which flies (*Musca domestica*) is the most important one. According to a research conducted at Universiti Teknologi MARA, Malaysia it was found that contribution to mango fruit set was 53% of total fruit set. Different crops rely on different insect pollinators. Some crops depend on specialist pollinators, for example beans are heavily reliant on bumblebees. Other crops like oilseed rape, apples and strawberries are pollinated by many different insects including solitary bees, honey bees, bumble bees, hover flies and other flies. The insects important for pollinating crops can vary from year to year and from place to place and are affected by the climate, weather and local farm management

| Insect group | Pollination type |
|---|---|
| Butterflies | Psychophily |
| Small moths | Phaleophily |
| Hawk moths | Sphingophily |
| Beetles | Cantharophily |
| Syrphid and Bombylid moths | Myophily |
| Carrion flies | Saprophily |

| | |
|---|---|
| Bees | Mellitophily |

**Crops benefitted by Pollinators**

- **Fruits and Nuts:** Almond, apple, apricot, peach, strawberry, citrus, litchi, fig etc.
- **Vegetables:** Cabbage, cauliflower, carrot, coriander, cucumber, melon, onion, pumpkin, radish, turnip etc.
- **Oil seed crops:** Sunflower, rape seed, mustard, safflower, sesame, etc
- **Forage seed crops:** Lucerne, clover, etc.

**Percent Increases in yield due to Bee pollination**

| S.No | Crops | Percent |
|---|---|---|
| 1. | Mustard | 43% |
| 2. | Sunflower | 32-48% |
| 3. | Cotton | 23-53% |
| 4. | Lucerne | 11.2% |
| 5. | Onion | 93% |
| 6. | Apple | 44% |
| 7. | Cardamom | 21-37% |

**List of Crops and the insects that pollinate them**

| Insect | Family | Order | Crops pollinated |
|---|---|---|---|
| Honeybees | Apidae | Hymenoptera | Sun flower,cotton, tobacco, alfalfa and clover, coconut |
| Weevil: *Eladeidobius kamerunicus* | Curculionidae | Coleoptera | Oilpalm |
| Hover flies and Syrphid flies | Syrphidae | Diptera | Carrot, bhendi and pulses |
| Fig wasps: *Blastophaga psenes* | Agonidae | Hymenoptera | Fig (Both Smyrna and Capri fig) |
| Carpenter bee | Anthoporidae | Hymenoptera | Ridge gourds, tomato |
| Digger bee | Anthoporidae | Hymenoptera | Vegetable crops |
| Mining bee | Andrenidae | Hymenoptera | Water melons, apple, cucumber |

Other pollinators: Butterflies (*Deilaphila sp.*)
Moths (*Acherontia sp.*)
Stingless bees (*Tetragonula sp.*)

Among many insect pollinators, bees play a vital role in crops pollination.

**Protecting Pollinators**

- Good stewardship practices by the crop protection industry, farmers, and beekeepers are necessary for protecting the health of pollinators.
- The crop protection industry is committed to educating farmers on stewardship best practices to limit any risks to pollinators.
- The crop industry relies on our pollinators and wants to keep them safe and healthy.
- Farmers can improve pollinator habitats by planting flower borders around crop areas.
- Beekeepers must be vigilant in monitoring for disease and mite levels in a colony

**Management of Bees for Pollination:**

- Place hives very near the field (source) - to save bee's energy
- Migrate colonies near field at 10% flowering
- Place colonies at 3/ha - Italian bee; 5/ha - Indian honey bee
- The colonies should have 5-6 frame strength of bees, possess sealed brood, have young mated queen
- Allow sufficient space for pollen and honey storage

**Major Threats to Pollinators :**

Many pollinators are adversely affected when large, intact tracts of habitat are broken up into smaller, isolated patches by road construction, development, or agriculture. Pesticides often kill directly, but sub-lethal amounts can also be detrimental to bees and other pollinators by impeding their ability to navigate or forage. The use of herbicides that eradicate important forage plants for bees and other pollinators is an additional problem. Systemic insecticides applied to seeds can contaminate the pollen grains that are an essential source of food for bees and their young. Pollinator populations due to colony collapse disorder and mite attack have increased concerns for food security, food quality and farming practices around the world.

**Conservation of pollinators:**

Increase the available foraging habitat to include a range of plants blooming at different times to provide nectar and pollen throughout the seasons. The wild flower planting function by attracting pollinators from the surrounding landscapes to the farm scape and ideally to "spill over" to provide pollination services. The wildflower plantings have been demonstrated as an effective practice for benefiting pollination by increasing crop production. Provide the alternate hosts. Artificial food supplements. Reduce the risk to bees from the use of insecticides and herbicides, which directly kill pollinators or the plants they rely on. Select less toxic insecticides or utilize alternative strategies to manage pest insects and minimize the use of insecticides.

**Conclusion:**

Conservation of existing population of pollinators potential to help promote the growth and stability to better crop production and low cost and eco friendly safer to the environment. Insect Pollinators play an important role to maintain the ecosystem healthy by their friendly activities to the human beings.

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