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Description and management strategies of important pests of pear: A review

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Abstract
The primary insect and mite pests of pear are codling moth, pear psylla, mites and borer. Over the last 20 years, insect damage and the cost of control have risen substantially. Pear growers currently spend as much as $14 million annually on insecticides. Increasing costs associated with pest control including increased pesticide resistance, reduced pest management options and increased chemical costs have made pear production more challenging. The objective of an integrated disease management program is to provide a commercially acceptable level of disease control from year to year while minimizing the cost of disease management. For each orchard, a program needs to be developed that integrates all available control tactics. Accurate disease identification is critical in making smart disease management decisions. San Jose scale can infest apples, pears, peaches, and plums. While *Cacopsylla pyricola* is the most troublesome insect pest of pears and Codling moth is a serious pest of apples and pears. It is important for growers to recognize all stages of these insects and mites that attack pears. Proper identification is critical to making the correct management decisions. We have discussed most effective strategies to control these insect and pest through chemical, biological and cultural operations in pear growing regions in India. The main objective of this review article is earlier pest identification of pear crops.

Keywords: Pear, pest, control, production and management

1. Introduction
The pear belongs family Rosaceae, is any of several tree and shrub species of genus Pyrus [4]. It is also the name of the pomaceous fruit of these trees. Several species of pear are valued for their edible fruit, while others are cultivated as ornamental trees. The genus Pyrus is classified in sub tribe Pyrinae within tribe Pyreae [4]. The pear is native to coastal and mildly temperate regions of the Old World, from Western Europe and North Africa east right across Asia [1]. Pear is grown in temperate and subtropical condition because of its wider climatic and soil adaptation. Scattered plantations of pear are found growing right from the temperate hilly region to warm subtropical valley areas of the region [8]. *Pyrus communis* is a deciduous small to medium-sized tree to 10 m tall (normally 3-5 m in cultivation), with a pyramidally shaped crown. The conical erect trunk bears small, reddish-brown, narrow-angled branches [5]. The grey-brown bark has shallow furrows and flat-topped scaly ridges. Leaves alternate, simple, elliptic/ovate with a finely serrated margin, obtuse tips, 2.5-10 cm long and 3-5 cm wide, shiny green above, paler and dull below, glabrous. The petioles are stipulate and the buds are involute, with imbricate scales. Flower corymbose inflorescences, 5-7.5 cm wide, containing 5-7 showy white, 2.5-3.5 cm wide flowers, borne from terminal, mixed buds of short spurs, appearing before or with the leaves. The spurs are very short and lateral branches [21].
China is the leading producing country of pears in the world recording a production of 17.3 million metric tons in 2013 [20]. Pears are mainly produced in large scale in China with several large pears farms in the country. The US is the second largest pears producer and recorded 0.795 million metric tons during the same period [20]. Other top pears producing countries include Italy, Argentina, and Turkey. The total world production in 2013 stood at over 25 million metric tons according to the UN Food and Agricultural Organization. While India production is 306 metric tonnes in 2017 [20].
The genus Pyrus (24 primary species) is in the subfamily Pomoideae, along with apple, loquat, medlar and quince [10]. The genus Pyrus probably originated in the mountain regions of what is now western and southern western China and evolved and spread eastward and westward. The species *P. communis* possibly is derived from the species *Pyrus nivalis* Jacq. and *Pyrus*

caucasica Fed [15]. Many improved named varieties have been derived from this species. Pears are self-sterile and need more than one variety planted within 12 or 15 m of each other in order to cross-pollinate. It flowers around March April, while fruiting occurs in July-September [18]. Some varieties (eg. Seckel and Bartlett) do not pollinate each other. The pollinators are honeybees. The fruit is eaten fresh, in fruit salads, or more rarely, canned. Sometimes, they are dried or candied. They are also used in jams and jellies. Its wood is brown-reddish, compacts, with several applications such as in furniture. Pear juice has been found to cause chronic, nonspecific diarrhea in infants and children. This stems from the abnormally high levels of fructose and sorbitol relative to glucose compared to other foods [1]. The same antibiotic-like substance (phloretin) found in apple bark is present in bark of pear. While in Europe, the alcoholic cider "Perry" is made from the pear.

2. Objective of the Study

The main objective of this review paper is to provide broad spectrum to local peoples to identifying the pear pests and their management before damaging the pear crops.

3. Description of Insect and Mites Pests of Pear

3.1 San Jose scale

Nymph: Female San Jose scales lay eggs which immediately hatch to colourless that emerge from under the edge of the scale covering. Each female lay birth to 200-400 eggs. These tiny yellow crawlers wander in a random fashion until they find a suitable place to settle. Immediately upon settling, the crawlers insert their mouthparts into the host plant and begin feeding and secreting a white waxy material (white cap stage); eventually the waxy covering turns black and is known as the black cap stage [2]. Later the covers turn various shades from gray to black.

Adult: Immature male and female scales are indistinguishable until the first molt. At this time, the male scale covering begins to elongate, while the females remain circular. Males molt a total of four times. Following the final molt, adult male scales emerge from the scale covering as tiny, yellow winged insects. They mate with the females who remain under the scale covering. Female insect body covered with grey scales. Yellow lemon coloured female is visible when covering is lifted. Female scales are very prolific and over a 6-week period can produce approximately 400 young. Crawlers move around for a short period in search of a suitable place to settle [4]. It takes 25 days for males to mature and 31 days for females Five to six generations in a year [1].

Symptoms of damage:

- Nymph and female scales attack all above ground parts
- Feeding site turns into a characteristic purplish red colour
- Initially growth of plant is checked but as scale increases in number plant may die
- Fruits will have distinct “measles” spots on the surface.

3.2 *Pear psylla*

Egg: Eggs are minute, oval, and creamy white to yellow. Eggs laid before buds open in spring, and through early fall, eggs are deposited in lines or rows on the terminals and fruit spurs after buds open, eggs are deposited along mid-veins and petioles of developing leaves and on stems and sepals of blossoms. Eggs hatch when foliage appears and continue throughout growing season [18].

Nymph: Early instars are about 1.6 mm long and light yellow; later instars are dark green to dark brown with wing pads and two conspicuous red eyes. Nymphs are cylindrical, but appear flattened and found on the undersides of leaves [3]. Pass through five instars, which are generally covered by a drop of honeydew. Moves little at first but later instars move easily. Feeds and develops on new growth and water sprouts. Produces honeydew.

Adult: Adults are 4 mm long and red-brown to black; larger and darker than summer adults. It resembles miniature cicada with wings held roof-like over the abdomen. Hides under bark, under litter on the orchard floor, or in sites outside the orchard. Adults leave the pear trees in Oct.-Nov. for wintering sites and return about 6 weeks before bloom. Feed by sucking juice from the host tree. Begin laying eggs after buds begin to swell [11].

Damage symptoms: Nymphs and adults suck sap primarily from the tender foliage of the new shoots and water sprouts. Feeding by nymphs produces a large amount of honeydew, which makes the tree sticky and promotes the growth of sooty mold (black fungus). The honeydew can run onto fruit causing dark russet blotches or streaks resulting in unmarketable fruit [8].

3.3 Green peach aphid

Egg: Eggs are deposited on *Prunus* spp. trees. The eggs measure about 0.6 mm long and 0.3 mm wide, and are elliptical in shape. Eggs initially are yellow or green, but soon turn black. Mortality in the egg stage sometimes is quite high. Nymph: Nymphs initially are greenish, but soon turn yellowish, greatly resembling viviparous (parthenogenetic, nymph-producing) adults. There are four instars, with the duration of each averaging 2.0, 2.1, 2.3, and 2.0 days, respectively. Females gave birth to offspring six to 17 days after birth, with an average age of 10.8 days at first birth. The average length of life is about 23 days, but this was under caged conditions where predators were excluded [4]. The daily rate of reproduction averaged 1.6 nymphs per female. The maximum number of generations observed annually during these studies was determined to be 20 to 21, depending on the year [8].

Adult: Up to 8 generations may occur on *Prunus* in the spring, but as aphid densities increase winged forms are produced, which then disperse to summer hosts. Winged aphids have a black head and thorax, and a yellowish green abdomen with a large dark patch dorsally. They measure 1.8 to 2.1 mm in length. Winged green peach aphids seemingly attempt to colonize nearly all plants available. They often deposit a few young ones and then again take flight. This highly dispersive nature contributes significantly to their effectiveness as vectors of plant viruses [12].

Damage symptoms

- Green peach aphids can attain very high densities on young plant tissue, causing water stress, wilting, and reduced growth rate of the plant
- Prolonged aphid infestation can cause appreciable reduction in yield of root crops and foliage crops. Early season infestation is particularly damaging to potato, even if the aphids are subsequently removed
- Contamination of harvestable plant material with aphids, or with aphid honeydew, also causes loss. Blemishes to

the plant tissue, usually in the form of yellow spots, may result from aphid feeding [18].

3.4 Stem borer

Egg: Female lays egg inside cavity on a shoot. Eggs are very difficult to see and are laid singly on the trunk of the tree [14].

Larva: Larvae of all three species are dirty white with a reddish-brown head and thoracic shield (area behind the head). Grub emerges in 7-8 days and start feeding by boring inside the stem. Grub longevity 2 years. Grub remains quiescent during winter and resumes feeding in March.

Pupa: Pupae are small, yellow-brown and sometimes observed as pupal cases partially protruding from the adult exit holes in the trunk or infested burr knots. Pupation takes place inside a tunnel made in the woody tissue.

Adult: Adult beetles 35-50 mm long and grey in colour having long antennae [13].

Nature and symptoms of damage

- Caused by grub and adult, grub more destructive
- Grub makes a tunnel and reaches close to trunk of tree
- Vitality and productivity of plant is greatly impaired.

3.5 Root borer

Egg: Female lays eggs singly or in small clusters in soil. Eggs are 1.3 mm in size. Newly laid eggs are white with a tinge of yellow and become dark brown before hatching [17].

Grub: Grubs feed on the root. Grub longevity 3.5 years. Grubs are cruciform, yellowish-white in colour. Development period ranges between 3-4 years. The full feed grub reach 80 mm length and 12 mm in width.

Pupa: The pupae are about 48 mm long and usually found about 20–30 cm deep in the soil. Pupation in earthen cell inside soil.

Adult: The adult beetle is chestnut red in color and bears long serrated antennae.

Symptoms of damage

- Grubs either bore or girdle around the roots
- The leaves become small and the branches wither
- Tree becomes shaky and may die [19].

3.6 Codling moth

Egg: Eggs are deposited singly on pears and leaves. Each egg is about the size of a pin head and is translucent, gradually darkening as the egg nears hatching. Eggs hatch in six to 14 days, depending on temperature. Within 24 hours of hatching the larvae burrow into the fruit. The first instar larvae have a pink body with a black head and are approximately 1/10 inch in length [5]. The number of eggs laid per female ranges from 30 to 70 [15].

Larva: After the eggs hatch, young larvae seek out and bore into fruit or developing nuts. Codling moth overwinters as full-grown larvae within thick, silken cocoons under loose scales of bark and in soil or debris around the base of the tree. Larvae appear to be cannibalistic. Full grown larva pinkish or creamy white with brown head and pupates in the soil litter.

Pupa: After completing development they leave the fruit and drop from the trees to search out pupation sites and continue the life cycle in the soil or on debris under the tree; some crawl back up the tree to pupate in bark crevices [6]. The larvae pupate inside their cocoons in early spring and emerge as adult moths mid-March to early April. The moths are active only a few hours before and after sunset, and they mate when sunset temperatures exceed 62°F.

Adult: Adults are about 1/2 to 3/4 inch long with mottled gray wings that they hold tent like over their bodies. Their appearance blends well with most tree bark, making them difficult to detect. If For trapping the adults, we can distinguish codling moth from other moths by the dark, coppery brown band at the tip of their wings. Adult forewings are dark grayish with waxy lines with a copper colored eye like circle toward margin [13].

Symptoms of damage:

- It is a direct pest and hence causes severe damage to the fruit
- Neonate larva enters the fruit through calyx and feeds on seed
- Infested fruits lose their shape and fall prematurely
- 30 to 70 per cent pear fruits are rendered unmarketable [9].

3.7 Thrips

Egg: The eggs are deposited within plant tissues singly [3].

Nymph and pupa: Larvae have two stages, which feed on plant tissues. The second instar larvae, when mature, fall to ground, where they molt to prepupae and pupae in the soil.

Adult: After emergence, the adults move to the growing parts of the plants such as young leaves, flowers, or young fruits, where they feed and lay eggs (about 200 eggs per female). Adults are usually found on young leaves, while larvae are found on lower or older leaves. At 25°C, the life cycle is completed in approximately 17 days. Adults are winged sucking rasping insects ranging from 5-14 mm in length. Their slender bodies are shiny pale or black with silver stripes. Life cycle completed in 11-43 days [7]. Produce many generations in a year heaviest damage occure in spring. In colder region, life cycle is longer with fewer generations [17].

Damage

- Most species of plant feeding thrips, have rasping and sucking mouthparts
- The surface of the leaf develops a crinkled silvery appearance as a result of damage to cells below the surface
- Lightly-infested plants show silvery feeding scars on the under surface of leaves, especially alongside the mid rib and veins
- Heavily-infested plants show silvering and browning of leaves, stunting of young leaves and terminal growth, with fruit scarred and deformed
- Developing leaves become distorced in the growing tips.

3.8 Mites

Egg: Overwintering eggs are deposited in groups on roughened bark areas, especially around the base of buds and fruit spurs. Egg hatch is closely correlated with bud development and first occurs when buds are in the tight

cluster stage; hatch is better than 50% complete at the pink stage, and virtually 100% complete by the end of bloom. The first summer eggs as a rule can be found at petal fall or at latest by fruit set. The summer eggs are globular and somewhat flattened (onion shaped). They are bright red to dark orange and average 0.13 mm in diameter [9]. The overwintering egg is deeper red and slightly larger, averaging 0.14 mm. The egg surface is ridged with the grooves running toward the top center from which a slender tapering stalk (0.1 mm) arises. The average incubation period of the summer eggs for each generation varies from 6.7 to 14.4 days, the shortest period being in mid-summer [11].

Nymph: Nymphs consist of larva, protonymph and deutonymph. A quiescent or resting period precedes each molt to the following stage. The hatching larva is about 0.2 mm in length, light orange in color and 6 legged. All subsequent stages have 8 legs. With the exceptions of an increase in size and the ability to differentiate sexes in the deutonymphal stage, there are no conspicuous changes in structure or color between the nymphal instars. The average 43 developmental time from eclosion to adulthood ranges from 5.5-15 days, depending on the generation [11].

Adult: The sexes of the adults are readily differentiated. The female has a globular body which ranges in length from 0.38 to 0.40 mm, is velvety brown to brick red, and has 4 rows of dorsal setae or spines borne on raised white tubercles. The body color and setal pattern distinguish this species from all other plant feeding mites [10]. The male is smaller, 0.26-0.28 mm in length, lighter in color and has a pointed abdomen and proportionately longer legs. Reproduction can be both sexual and parthenogenetic. Unfertilized eggs give rise to males only, while mated females produce both sexes. The average preoviposition period of females is about 2 1/2 days. Although some females in insectary studies have lived 39 days, the average life span is 18 days. The oviposition period averages 12.5 days with 18.8 eggs produced per female [18].

Symptoms of damage:

- European red mite feeds on leaves
- Severe mite injury produces browning and loss of colour in the leaves i.e. bronzing.

4. Insecticide Resistance and Its Management

4.1 Insecticide resistance: Resistance to insecticides may be defined as ‘a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species’ (IRAC) [21]. Cross-resistance occurs when resistance to one insecticide confers resistance to another insecticide, even where the insect has not been exposed to the latter product. Causes of resistance development: The causes and rate at which insecticide resistance develops depend on several factors, including the initial frequency of resistance alleles present in the population, how rapidly the insects reproduce, the insects’ level of resistance, the migration and host range of the insects, the insecticide's persistence and specificity, and the rate, timing and number of applications of insecticide made [11]. For instance, insect pests that survive in large populations and breed quickly are at greater advantage of evolving insecticide, especially when insecticides are misused or over-used. General strategy for insecticide resistance management: The best strategy to avoid insecticide resistance is prevention and including insecticide resistance management tactics as part of a larger integrated pest management (IPM) approach [11].

4.2 Monitor pests: Monitor insect population development in fields to determine if and when control measures are warranted. Monitor and consider natural enemies when making control decisions. After treatment, continue monitoring to assess pest populations and their control.

4.3 Focus on Agro ecosystem analysis (AESA): Insecticides should be used only as a last resort when all other non-chemical management options are exhausted and Pest: Defender ratio (P: D ratio) is above 2: 1. Apply biopesticides/chemical insecticides judiciously after observing unfavourable P: D ratio and when the pests are in most vulnerable life stage. Use application rates and intervals as per label claim [2].

4.4 Ecological engineering for pest management: Flowering plants that attract natural enemies as well as plants that repel pests can be grown as border/intercrop [6].

4.5 Take an integrated approach to managing pests: Use as many different control measures as possible viz., cultural, mechanical, physical, biological etc. Select 31 insecticides with care and consider the impact on future pest populations and the environment. Avoid broad-spectrum insecticides when a narrow-spectrum or more specific insecticide will work. More preference should be given to green labeled insecticides [15].

4.6 Mix and apply carefully: While applying insecticides care should be taken for proper application of insecticides in terms of dose, volume, timing, coverage, application techniques as per label claim.

4.7 Alternate different insecticide classes: Avoid the repeated use of the same insecticide, insecticides in the same chemical class, or insecticides in different classes with same mode of action and rotate/alternate insecticide classes and modes of action.

4.8 Preserve susceptible genes: Preserve susceptible individuals within the target population by providing unsprayed areas within treated fields, adjacent "refuge" fields, or habitat attractions within a treated field that facilitate immigration. These susceptible individuals may outcompete and interbreed with resistant individuals, diluting the resistant genes and therefore the impact of resistance [24].

5. Integrated Pest Management (IPM) Strategies in Pear Production

IPM is an approach to pest control developed in the 1960s, and has been the prevailing school of thought since that time. By definition, IPM seeks to control pests (arthropod pests and diseases, weeds, nematodes, and vertebrates) using multiple, complementary tactics in an environmentally and economically sound manner [12]. Tools such as monitoring, sampling/scouting, biological control, physical/cultural control, sanitation, host plant resistance, and chemical control are all parts of the IPM toolbox used by pear growers and advisors in the India [4]. For each crop/pest situation, the goal is to keep pests below an economic threshold with a selection of these tools, and harmonize them with the control of other pests. Pesticide options were few, and generally the same

materials were available for apples and pears. Because of this, orchards could be inter-planted with both crops, without problems of label restrictions [23]. Lead arsenate, petroleum oils, lime-sulfur, soap, Bordeaux mixture and nicotine were the mainstays of tree fruit pest management in the first half of the 20th Century. In 1939, pear psylla was detected in Washington State, and had spread to Medford, Oregon by the 1950s [23]. Although technically an indirect pest (feeding on leaves and shoots rather than on fruit, as does codling moth) pear psylla soon became a very serious pear pest, eclipsing codling moth in importance in some regions. The recent advances in control of codling moth, such as mating disruption or sterile insect releases, have had a positive impact on pest management and fit well into IPM programs. Pear cultivars vary more widely than apple cultivars in their susceptibility to codling moth, although all are vulnerable to attack [16]. The winter pears are less susceptible to codling moth injury, especially during the first generation of codling moth when the immature pears are very hard. Summer pears are softer and more aromatic, and are more vulnerable to attack.

6. Pear Pests Management Strategies

6.1 Codling moth (*Cydia pomonella*): This insect can be a serious pest in pears, especially in the warmer, dryer areas of the India and North Pacific region. Bartlett pears are the most susceptible to codling moth injury, especially in the early season. Most of the early-season injury on pears occurs through the calyx end of the fruit. All pears become more susceptible to codling moth injury later in the season [22].

Chemical control: Insecticide resistance is an issue; growers and advisors avoid treatment of consecutive generations of codling moth with same materials or modes of action.

- Acetamiprid (Assail): Widely used; good efficacy when used earlier in season
- Chlorantraniliprole (Altacor): Very effective; used more in the all over India
- Granulosis virus (Cyd-X): A biologically-based pesticide. Requires frequent applications when pest pressure is high.
- Horticultural oil: Widely used [12].

Biological control: General predators, including bats and spiders, feed on the adult moths, and arthropod predators (spiders, ground beetles, and vertebrate predators such as birds and mice) feed on mature larvae seeking overwintering sites.

Cultural control: Remove brush, debris, and infested fruit from the orchard.

- Use best practices for harvest bin placement and treatment (e.g. hot water, tarping, fumigation) in the orchard to minimize codling moth infestation.

6.2 Mites: Pear rust mite (*Epitrimerus pyri*) and Pearleaf blister mite (*Eriophyes pyri*) can be a problem pest in all pear-growing regions. This is especially true for pears grown for export.

Chemical control:

Pre-bloom control:

- Calcium polysulfide + oil (Sulforix and other brands): Widely used by both conventional and organic growers.
- Micronized sulfur + oil: Widely used by both conventional and organic growers.

Growing season control:

- Abamectin (Agri-Mek): widely used for psylla and spider mites and is effective on rust mite.

6.3 Pear psylla (*Cacopsylla pyricola*): Pear psylla is a critical insect pest in all regions of India and Pacific Northwest pear production [13]. Pear psylla control and pear psylla damage can have a huge economic impact on growers [11].

Chemical control: Pear psylla often develops resistance rapidly to chemical controls. Alternating chemistries and modes of action is important for growers and advisors.

Dormant application:

- Esfenvalerate (Asana XL): Registered but not sold in tree fruits; more effective and less disruptive products available.
- Fenpropathrin (Danitol): Not widely used; expensive.
- Horticultural oil: Widely used to delay egg laying.
- Kaolin (Surround): Widely used and effective.

Biological control

Predacious plant bugs (*Deraeocoris*, *Anthocoris*, *Campylomma*) are among the more important predators of pear psylla. Other predators include lady beetles (adults and larvae), lacewings, and earwigs. Parasitic wasps (*Trechnites* sp.) can also provide a level of population suppression. If natural enemies can be conserved within the orchard, biological control of pear psylla can be effective [15].

Cultural control: • Avoid promoting unnecessary vigor • Remove suckers from interior of the trees, which removes psylla eggs and nymphs and increases spray coverage • Overhead irrigation might help control psylla pressure due to frequent rinsing and washing; but this is not common practice due to increased risk of fire blight disease, and potential for rinsing insecticide applications from trees.

6.4 San Jose scale (*Quadraspidiotus perniciosus*): San Jose scale is serious pest of all fruit trees and many ornamental and wild trees and shrubs throughout the India, particularly in hot, dry climates. Scale insects are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts [21].

Chemical control: In-season sprays are timed to match crawler emergence.

Pre-bloom control: Buprofezin (Centaur): Effective.

- Calcium polysulfide (Sulforix, others): Used with oil, especially in organic production, but resistance can be an issue.
- Horticultural oil + an organophosphate (e.g. Supracide or Lorsban): Lorsban is used and effective; Supracide is expensive and not as widely used.
- Pyriproxyfen (Esteem): Widely used; effective. Growing season control: (timing is difficult during the season; most effective controls are pre-bloom)
- Acetamiprid (Assail): Used for other pests; can also suppress scale.
- Buprofezin (Centaur): Used; effective
- Diazinon: Effective but not widely used; disruptive to pollinators and natural enemies.
- Imidacloprid (Provado): Used for other pests; can also suppress scale.

- Pyriproxyfen (Esteem): Widely used; effective.
- Spirotetramat (Ultor): Also used for other pests but effective in controlling scale [17].

Biological control: Larvae of green lacewings and other insects are aggressive predators of scale, along with a number of parasitic wasps. However, biological control does not necessarily prevent significant scale infestations and certain chemical pesticide applications can be disruptive to effective control by natural enemies [20].

6.5 Thrips (*Taeniothrips inconsequens*): Western flower thrips is *Frankliniella occidentalis* cause serious damage in pear orchard in India as well as other regions of pear growers.

Chemical control: Cyantraniliprole (Exirel): New registration. Effective.
- Spinetoram (Delegate): Used. Effective.
- Spinosad (Entrust, Success): Used. Effective.

7. Conclusion
There are a number of diseases that commonly occur year after year in both commercial and home plantings of pears. These diseases do not infect at the same time but appear in a fairly regular sequence depending upon the weather and the development or phenology of the pear host, beginning at dormancy and continuing until fruit are harvested. As a consequence, a season-long program for disease management is often necessary in order to harvest a high percentage of useable fruit. Pears have a relatively large complex of potential arthropod pests, diseases, and weeds which must be managed on an annual basis. Historically, pear growers have relied on chemical control of major pests such as codling moth and pear psylla. Significant reductions in costs of insect and mite management have been demonstrated for pear when selective management programs are implemented. There are generally only partial effects for pest control which is insufficient to reduce the use of pesticides except for some pests, e.g. mites and psyllids that can be tolerated at high levels of populations without any damage on fruits or reduction in yield. The challenge mainly relies on integrating all these tools on different interconnected scales, from fruit tree leaf infrastructures to orchard and landscape scales, in order to maximise ecosystem services on each scale and to implement synergistic effects.

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