

Aonla Rejuvenation

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N.C.P.A.H., D.A.C., Ministry of Agriculture, Govt. of India
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FOREWORD

Aonla is not merely a source of nutrients and medicine as well and its cultivation is also highly remunerative for small and marginal farmers. Aonla production, in the yesteryears, has been exhibiting an upward swing in our country but its productivity is still much below the productive potentials.



In aonla, majority of the older plantations are of seedling origin embodying non-descript material and poor genetic potentiality culminating in senile condition. In several areas, plantations of improved varieties having good genetic potentiality have either gone unproductive or showing marked decline in productivity. This is the outcome of over crowded plantations, intermingling of large branches and meager foliage, allowing poor light availability to growing shoots within the canopy. This renders them uneconomical.

Having understood about the low yield and ticklish issues of environmental protection act, ICAR seized the opportunity to igniting the thought process at various levels through its vast network of research Institutes to offer a sustainable solution of the problem. Based on numerous research investigations, it could be summed up that the fruiting potential of the tree is largely governed by its architecture, canopy density and photosynthetic efficiency. The essentiality of developing and deploying appropriate technology to manage such senile orchards was considered significant to attain the competitive edge in commercial production in this extremely competitive world in the WTO regime and to meet the quality standards of the conscious consumers which has led to initiation of research efforts in this sphere at Central Institute for Subtropical Horticulture, Lucknow.

I appreciate the endeavours of my distinguished colleague authors who have woken up to the occasion and came out with judiciously planned and economically feasible technology, which would go a long way in converting a fruit forest to an orchard.

I hope, this bulletin will be an exceedingly useful source of information and guidance to orchardists, horticulturists, extension workers, teachers and students to understand the rejuvenation process for senile orchards.

A handwritten signature in black ink, appearing to read 'B.M.C. Reddy'. The signature is stylized and fluid.

(B.M.C. Reddy)
Director

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Lucknow

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Introduction

Aonla, also known as Indian gooseberry (*Emblica officinalis* Gaertn.), is indigenous to Indian subcontinent. Owing to its hardy nature, suitability to various wastelands, high productivity and nutritive ingredients besides having therapeutic values, aonla has become an important fruit. In fact, aonla, in its processed form is very popular among the social elites. As an indigenous fruit, it has extensive adaptability to grow in diverse climatic and soil conditions ranging from western and eastern Himalayas, Arawali, Vindhyan to southern hills. The climate ranges from hot tropical plains to humid subtropical mid-elevation hills is suitable for its cultivation. It is even raised in arid, semi-arid, coastal and warm temperate conditions successfully. Similarly, it grows well in saline, alkaline, and degraded as well as in sandy, red and clay soils.

Economic importance

Aonla is not merely a source of nutrients and medicine as well and its cultivation is also highly remunerative for small and marginal farmers. Traditionally, aonla has been a wanton crop of forest or household, but during the last decade, unprecedented expansion has been witnessed in the sphere of aonla cultivation across the country, utilizing the wasteland. This has resulted in efficient utilization of resources culminating in increase in farmers' income, nutritional security coupled with enhanced employment and rejuvenation of wastelands.

Various parts of aonla tree are of great economic importance. The edible fruit tissue contains protein concentration 3-fold and ascorbic acid concentration 160-fold more than those of available in apple. Aonla also embodies considerably higher concentration of most minerals and amino acids than available in apple. Aonla fruit is valued very high amongst the indigenous medicinal fruits and has even been recommended by the ancient Ayurvedic system for sound health. It is a boon for patients suffering from asthma, diabetes, anemia, cancer, tension, premature old age and loss and greyness of hair. Trifla, Chyavanprash and Amirt Kalash prepared basically from aonla fruits are popular not merely in India but across the world. Consumption of aonla imparts laxative effect. Fresh roots are panacea for jaundice and other abdominal diseases.

Present status

India ranks first in the area and production of aonla. Besides India, naturally growing aonla trees are also found in different parts of the world like Sri Lanka, Cuba, Puerto Rico, USA (Hawaii and Florida), Iran, Iraq, Pakistan, China, Malaysia, Bhutan, Thailand, Vietnam, the Philippines, Trinidad, Panama and Japan. Uttar Pradesh, Gujarat, Rajasthan, Tamil Nadu, Haryana, Maharashtra, Andhra Pradesh, Karnataka, Punjab and Himachal Pradesh are the major aonla growing states in India. Uttar Pradesh ranks first in its area and production. The major producing areas in Uttar Pradesh

are Pratapgarh, Sultanpur, Varanasi, Rae Bareli, Jaunpur, Kanpur, Fatehpur, Agra and Mathura districts. In Madhya Pradesh, the aonla-producing regions are Dewas, Hoshangabad, Shiwani, Tikamgarh, Betul, Chindwara, Shivapurkala, Panna, Rewa and Satna. In Haryana, aonla is principally grown in Bewal and Gurgaon areas. In Karnataka, Bilgiri Rangan Hills in Mysore is also another aonla producing area. In Tamil Nadu, concentrated production is evident around Salem and Dindugal. In Himachal Pradesh, aonla is grown in Palampur, Bilaspur and Hamirpur areas.

Production constraints

Canopy development in perennial crops has a seasonal as well as life long developmental pattern. The sum of development over individual season results in the final canopy dimension and form. In general, canopy of aonla has irregular shape. Trees of irregular



Old and crowded aonla orchard

shape and size are difficult to deal with and even culminate into poor fruit yield in the subsequent years as the lower branches of canopy gradually turns inert and infertile as well. In aonla, majority of the older plantations are of seedling origin embodying non-descript material and poor genetic potentiality which become senile. In several areas, plantations of improved varieties having good genetic potentiality have either gone unproductive or showing marked decline in productivity. This is the outcome of over crowded and intermingling of large branches and meager foliage, allowing poor light availability to growing shoots within the canopy. This renders them un economical. Such exhausted aonla trees can be rejuvenated by heading back of branches in winter for the production of new shoots, which can bear good crops in the years to come.

Points to be considered while adopting the rejuvenation technology

1. Plantations of commercial varieties where the canopy become over crowded resulting in reduction in yield can be rejuvenated followed by canopy management.
2. Older plantations of seedling origin which have become senile can be adopted for top worked by grafting (budding) with scion of superior varieties to upgrade seedling plantation with superior commercial varieties.

Aonla Rejuvenation



Heading back of branches

Technology for rejuvenating senile orchards

There is a tendency of over lapping of canopy between 10 and 12 years of age depending on the nature of variety unless the canopy is maintained by trimming and thinning. Plantation which have overlapping branches lead to dead wood development decline in yield in later years. Such plantation can be rejuvenated through canopy redevelopment. The



Beheaded branches showing emergence of new shoots

redevelopment of canopy is necessary in older plantations, when the canopies are overcrowded resulted in reduction in yield. This is possible by hedging of branches followed by shoot management to modify the tree structure and maintain canopy size.



Headed back tree with black plastic film



Tree growth after 5 months of heading back



Tree canopy after shoot thinning

The rejuvenation technology involves heading back (topping) of branches during December - January at a height of 2.5 to 3.0 m from the ground level depending on the structure of individual trees in the orchard. Before rejuvenation pruning, branches are marked with white chalk by making a ring around the branches. The selected branches should initially be cut from the under side on the lower side by giving at least 10 cm deep cut. Thereafter, the cutting should be done from the upper surface of the branch. The cut portion of the branches is then pasted with cow dung or copper oxychloride to avoid infection of fungal diseases. Immediately after heading back, the pruned wood needs to be removed from the orchard so as to prevent the damage by trunk borers.

Manipulation of vegetative growth

The new shoots arise on pruned branches of heading back and a few shoots are retained at proper spacing and growing towards periphery of trees. Successive



Pruning Shoot (50%) of its total length

removal of unwanted shoots, considering the vigour and growing direction is important. In this technique, only 4 to 6 shoots developing in outer directions on main limbs should be allowed to develop. Proper development of new canopy in horizontal direction should be kept in mind while practicing thinning of shoots. During May-June, the selected shoots are further pruned out to about 50 per cent of its total length for emergence of multiple shoots below the pruning points. This was



Tree canopy after shoot pruning

Aonla Rejuvenation



Development of better canopy as a result of shoot pruning

mainly done to modify the tree structure and maintain canopy size. Fruiting starts on third year after rejuvenation. Yield levels during initial year are slightly low, while the yield from third year onward is better than the unpruned trees.



Fruiting on rejuvenated aonla tree



Process of budding technique on beheaded tree

Rejuvenation by top working

Top working can be easily adopted in rejuvenated trees to upgrade the old and senile plantations of seedling progeny with superior commercial cultivars. Top working involves two steps (i) beheading of the tree to be top worked and (ii) budding with a elite material on the new flushes emerging out on the stumps of beheaded tree. The plants are headed back during December - January to the extent of 2.5 to 3.0 m above the ground level. Four to six shoots from the outer directions on main limbs should be allowed to develop. During June-July, scion of desired variety is grafted (budding) on these shoots. After



Better canopy after rejuvenation by top working

bud sprouting, the top portion of the shoot is removed. Numerous side shoots, which emerge on the pruned branches after the budding operation should be removed regularly as and when they emerge, so

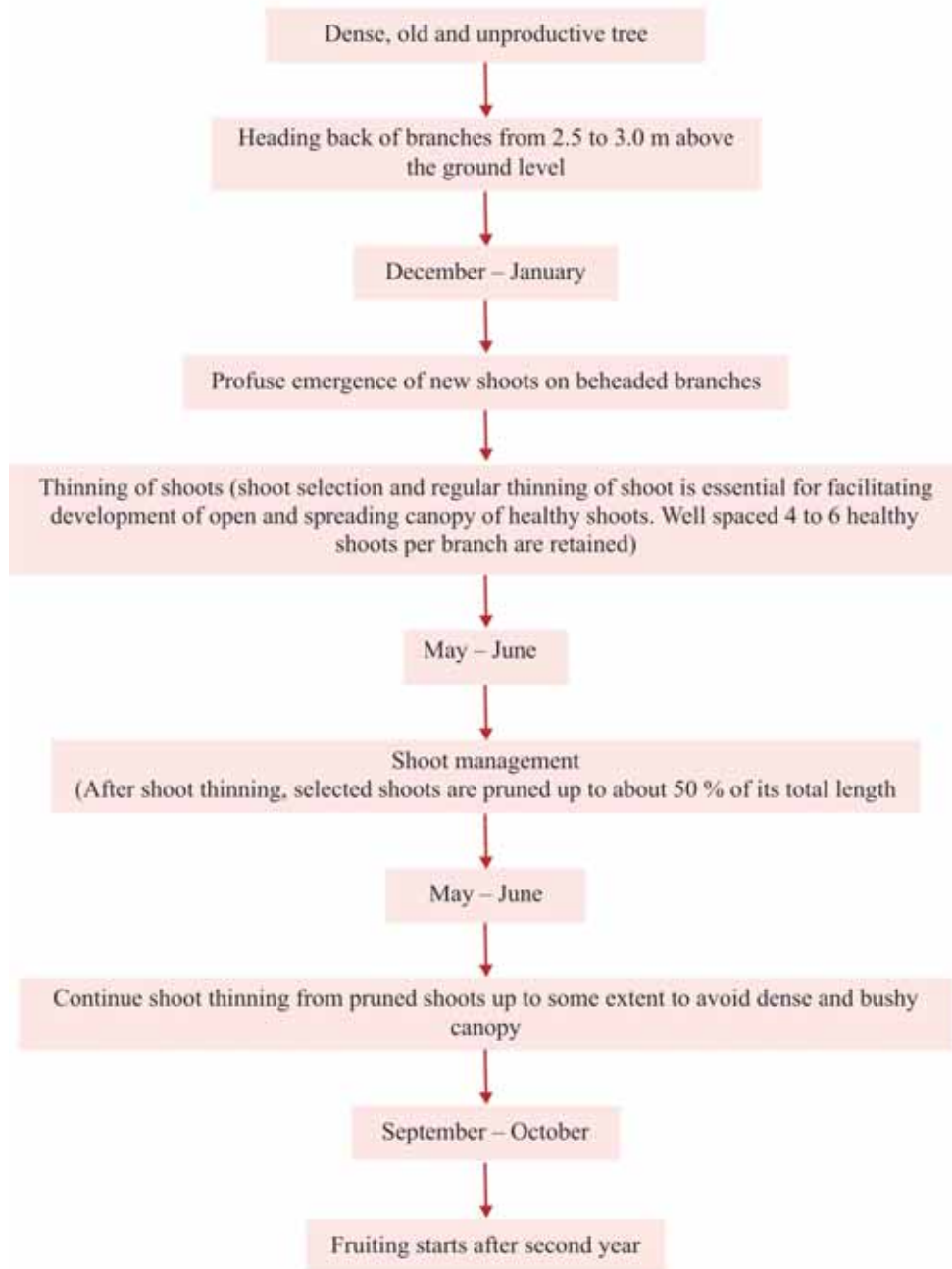
that tree of pure commercial variety is obtained. Since aonla is self incompatible, i.e. the pollens of same tree/variety can not fertilize its own ovary, the production from mono-culture orchards without appropriate polliniser varieties, suffers adversely as a result of problem of fruit set. Consequently, polliniser varieties are budded on developing shoots of pruned trees to strengthen pollination process and enhancement of fruit set and productivity. Budding with mixed varieties results in better yield. The best combination is NA-6 with NA-7; NA-7 with NA-10 and Kanchan with Krishna. Adequate care should be taken to manage the insect-pest problems as these plants are prone to insect and some times wind damage.



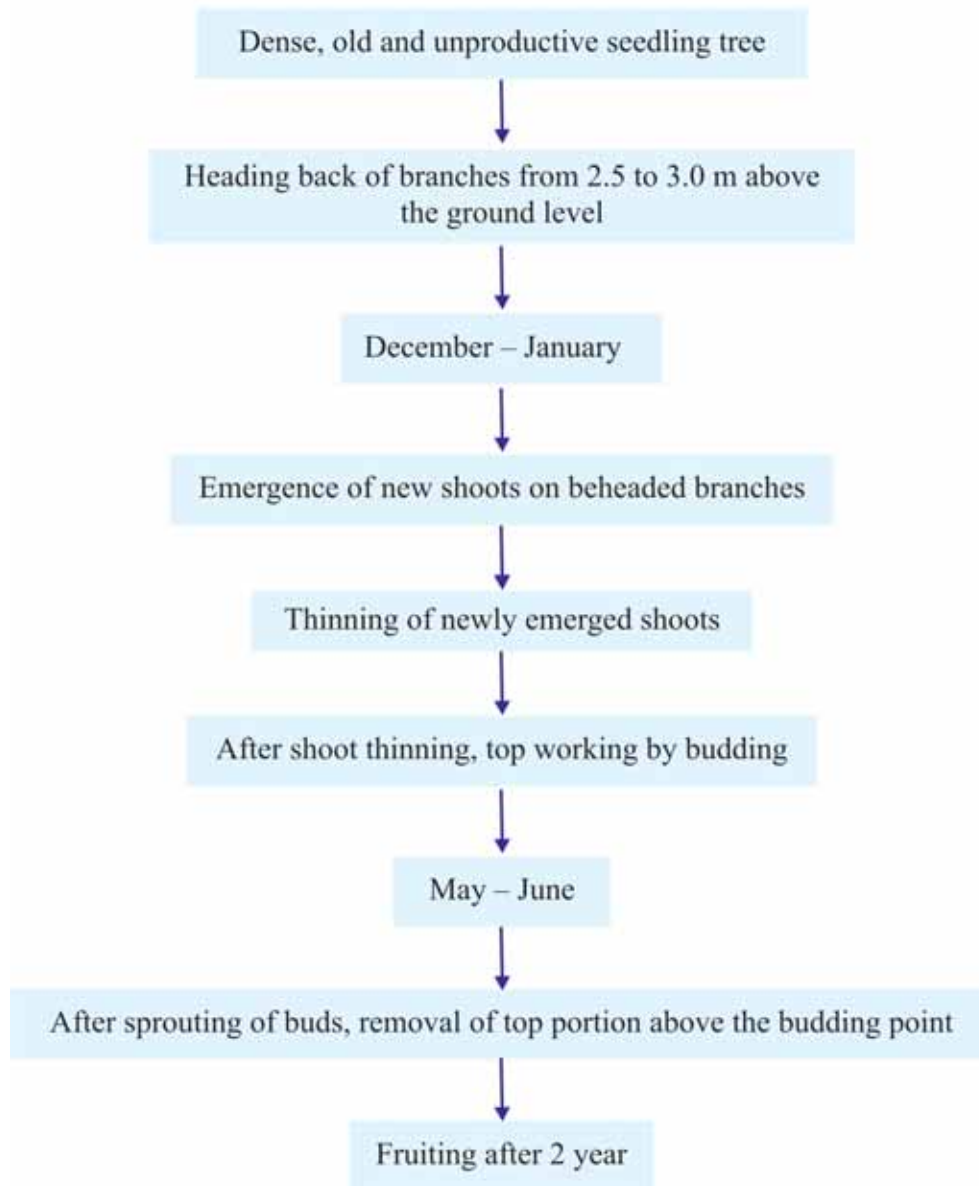
Fruiting on top worked tree

Aonla Rejuvenation

SEQUENTIAL STEPS FOR REJUVENATION TECHNOLOGY



SEQUENTIAL STEPS FOR TOP WORKING



Cultural practices in rejuvenated orchard

Intercropping in rejuvenated orchard

During initial 2 - 3 years after rejuvenation, aonla groves present an excellent opportunity for utilizing vacant interspaces in the orchard. Vegetables like bottle gourd, okra, cauliflower, coriander and turmeric; flowers like gladiolus and marigold have been found well suited for intercropping in rejuvenated aonla orchards. In salt affected soil or marginal soils, intercropping of Dhaincha for a few years is beneficial for improving the physico-chemical properties of the soil.



Elephant foot yam as intercrop in the rejuvenated orchards

Manuring and fertilizer

The nutritional requirement in rejuvenated aonla trees largely depends on soil fertility and production. During the phase of heading back, 50 kg FYM along

with 8 kg neem cake / plant is made. Six months after heading back manures and fertilizers may be given as 50 kg FYM + 4 kg neem cake + 1000 g Nitrogen + 500 g, potash and 750 g Phosphorus/ year. Fifty per cent of Nitrogen and entire dose of potash and single Phosphorus need to be applied in January-February and rest dose of nitrogen is applied in June. Fertilizers are applied in a ring which covers 50 cm away from the trunk and covering periphery of the tree. Soil should be dug to the depth of 8-10 cm and fertilizer should be properly mixed with the soil. Light irrigation is done immediately after the application of fertilizers. In sodic land, 100 g each of borax, zinc sulphate and copper sulphate should be applied along with fertilizers as per tree age and vigour. It is helpful in reducing fruit drop and improving fruit quality.

Irrigation

Aonla, being a hardy tree, requires less irrigation. During rainy and winter seasons no irrigation is required but is required at an interval of 10-15 days during dry summer (April-June). In headed back trees, irrigation is done just after rejuvenation. Adequate watering is a sine-qua-non for the optimum development of novel shoots in rejuvenated trees. If trees are not watered properly, there is always a feasibility that shoots do not grow to their appropriate level. It is, therefore, suggested to water those trees which are amputated for rejuvenation of old and senile orchards.

Mulching

Mulching at the base of pruned trees is done by using black polyethene sheet (400 gauge) or heavy mulching with organic material, such as, straw, dried grass, banana leaves, immediately surrounding the main trunk drastically reduces weed growth.

Mulching with organic materials should be applied thick enough (12 to 15 cm) to prevent weed growth simultaneously not stopping rain water penetration to the root area. Of late, plastic films have come into use for the purpose of mulching due to its inherent advantages of efficient moisture conservation, weed control and maintaining of soil temperature.



Mulching with black polyethene film

Besides, the volume of plastics material to be used per unit area is much less or than that of traditional mulch material and, hence, plastic films is easy to handle, transport and lay in the field. The use of plastic mulching is one such technology, which helps in utilizing the irrigation water to its last drip. In general,

black plastic film is used for mulching. Generally, the mulch film is spread around the soil/plant from all sides after rejuvenation of plants. After plastic mulch, drip irrigation is the best irrigation method. Wherever, drip irrigation system is not available, there alternative is to remove the film from one side to carry out irrigation by the help of irrigation channel. After irrigation, mulch film is once again properly placed and pressed under soil.

Management of pests and diseases

Diseases

There are a few important diseases, which are very dangerous for the aonla cultivation. As fruits are perishable in nature, even slight injury can cause storage and transit diseases. Some of the diseases of aonla are described below:

Rust

Rust of aonla is an important disease especially in Rajasthan and has been reported as grave problem in Udaipur district. Recently, it has been recorded in the areas of Lucknow and Pratapgarh as well. Initially black pustules appear at infected fruits which later develop in to a ring. The black spores are exposed after rupturing a papery covering. Fruits not only give dirty look but also simultaneously lose their market value.

Management

Three sprays of wettable sulphur (0.4%) at an interval of one month from July have been found useful in controlling the disease.

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Wilt

Recently, wilting of aonla plants have been recorded from Rajasthan. The main reason for wilting though was attributed to frost injury, but association of *Fusarium* sp. is also a reason for it.

Management

Mulching with available organic waste/black polyethylene film and cow dung pasting on tree trunk have been found quite effective in minimizing frost injury.

Sooty mould

The aonla trees, which are infested with scale insect, are generally affected by sooty mould. Sooty mould causes velvety covering of black fungal growth on surface of leaves, twigs and flowers.

Management

Sooty mould can be managed by spraying starch @2%. Monocrotophos @0.05% and wettable sulphur @ 0.2% can be mixed in starch if infection is more.

Anthracnose

Anthracnose on leaves and fruits is common during August - September. Initial symptom of the disease is in the form of minute, circular, brown to grey spots with yellowish margin on leaflets. On fruits, the depressed lesions are formed, which later turn dark in the centre forming acervuli often arranged in rings. Consequently, the fruits become shriveled and rot.

Fruit rot

Fruit rot is recorded in dropped fruits of aonla from Allahabad. The rot starts as a small brownish spherical necrotic spot which increases in circular fashion with the development of the disease. In advance stage, the spot becomes dark brown to black and neighboring spots coalesce.

Management

Fruit rot can be managed by spraying of carbendazim 0.1% and need to be done 15 days prior to fruit harvest.

Pests

Shoot gall maker

The pest attack nursery plants and old bearing trees. The insect is active from June to December. The pest causes gall formation on stem and terminal shoots. The larva of this moth tunnels in the apical portion of the shoot and infested portion bulge into gall. This pest is important as its large-scale infestation may result in stunted growth of the trees affecting flowering and fruiting. In the beginning of the infestation terminal shoots swell, which increase in size with the passage of time.

Management

Over crowding of branches should be discouraged and spray of 0.05% monocrotophos in the beginning of the season are recommended for the control of this pest.

Bark-eating caterpillar

The pest is widely distributed throughout the country. Generally, the incidence of the pest is more common in neglected and poorly managed aonla orchards. The infestation of this pest starts in the month of April with the emergence of moths. The attack of this pest may be identified by the presence of irregular tunnels and patches covered with silken-web consisting of excreta and chewed up wood particles, on the shoots, branches and trunk.

Management

In case of severe infestation, remove the webs and insert the swab of cotton soaked in monocrotophos and plug the holes with mud.

The larvae of this pest are parasitized by entomogenous fungus *Beauveria bassiana* in nature. This can be used as a potential bio-control agent.

Mealy bug

Incidence of mealy bugs has been noticed from March to July with the peak population in April-May. Excessive desapping by nymphs results in drying and dropping of leaves and flowers which affect the growth of the tree, flowering and fruiting. The attacked new shoots are found bending and twisting with yellowing of leaves.

Management

Prune affected parts and in case of severe infestation spray 0.05%

monocrotophos or 0.05% quinalphos.

Aonla aphid

The incidence of this pest is mainly seen from July to October with the peak period in September. The nymphs and adult females suck the sap. The infested leaves turn yellow and dry up. Presence of ants also indicates the infestation of aphids.

Management

The aphids should be managed by spraying of 0.06 dimethoate or 0.05% monocrotophos.

Stone Borer

This pest is found active from June to January. Tiny weevil emerges in the month of June with the onset of rains. The eggs are laid by excavating a cavity below the epicarp. Fruits of 1.5 to 2 cm in diameter are preferred for oviposition. Full grown larva comes out of the fruit by cutting small circular hole.

Management

First spray of 0.2% carbaryl or 0.04% monocrotophos or 0.05% quinalphos or 0.07% endosulfan at pea size of fruit. Second spray may be done at fortnightly interval with changed insecticide, if needed.

Fruit Midge

Incidence of this pest occurs in the fruiting season in aonla from September to January. The eggs are laid inside the

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fruits. Immature larvae are creamish-white, while mature are pinkish-orange in colour. In the beginning, small grey-black spots appear at the site of infestation. Desi varieties of aonla are more susceptible.

Management

Spray of 0.2% carbaryl or 0.04% monocrotophos or 0.05% quinalphos at the beginning of the fruiting is recommended.

Physiological Disorder

Internal necrosis

Internal necrosis has been observed in aonla fruits. Cultivar Francis appears to be highly susceptible followed by Banarasi. The symptoms start with the browning of the innermost part of mesocarpic tissue at the time of endocarp hardening in the 2nd or 3rd week of September which later extends towards the epicarp resulting into brownish black appearance of the flesh.

Infection has not been noticed on other aonla cultivars like Chakaiya, NA-6 and NA-7. Hence, the cultivation of these varieties needs to be encouraged.

Management

Combined spray of zinc sulphate (0.4%) + copper sulphate (0.4%) and borax (0.4%) during September- October has been found effective.

Management practices to be followed prudently by growers after rejuvenation

- Marking of tree with white chalk for rejuvenation pruning.
- After marking, cutting should be done from lower surface of the branch and later from upper surface to avoid cracking as well as bark splitting .
- Application of cow dung or copper oxychloride on cut surface to check the microbial infection.
- Ploughing of rejuvenated orchard and preparation of basin and irrigation channel.
- Application of FYM @ 40-50 kg/plant soon after rejuvenation.
- Insure irrigation soon after rejuvenation for shoot sprouting and proper development of tree canopies.
- Mulching around trees with black polyethene film.
- Care of newly emerged shoots.
- Thinning of shoots and retaining 4 to 6 outward growing, well spaced and healthy shoot per pruned branch.
- Good phytosanitary procedures are to be adopted to manage the rejuvenated plants.
- Regular observation for incidence of stem borer. If the infestation is observed then immediately control measures, comprising pulling out the grubs from the holes with help of iron spoke and plugging the holes with

monocrotophose soaked cotton swabs following by mud plaster to be taken up.

Jaunpur and Sultanpur districts of U.P.

Income generated during the process of rejuvenation technology

- Sale of wood (cut material). The cost of cut materials depends upon the size of trees. In general, the total cost of wood ranging from Rs. 50,000 to 60,000 per hectare has been obtained in different locations of Pratapgarh,

- The interspaced are used to grow suitable inter crops, which not only provide nutrition to the main crop of aonla, but also generate additional income.

In the 1st Year, farmers also gained income from raising intercrops and it has been observed that nearly Rs. 25,000 to 30,000 could be gained from the raising elephant-foot (Yam), Chillies, etc.

Cost of rejuvenation technology

(Spacing 8.0 x 8.0 m, accommodating 157 plants/ha)

The operation cost involves cost of labour for rejuvenation pruning, intercultural operations, shoot thinning, irrigation, manuring and fertilization, plant protection measures, etc. The material cost involves cost of manures, chemicals, fertilizers, insecticides, fungicides, diesel, etc.

Activates	Total cost (Rs.)
Labour cost (First step)	
Heading back of branches from 2.5 to 3.0 m height above the ground level +removal of all the cut materials from the orchard + pasting of cow dung or copper oxy-chloride on cut portion + pulling out the caterpillar by increasing iron spoke in the shelter holes, removing the webs and inserting the swab of cotton soaked in monocrotophos and plugging the holes with mud + painting of exposed wood with copper and lime + making basin around the tree + irrigation channel + hoeing and weeding of basin + application of FYM @ 50 kg/basin/plant and mixing them thoroughly with soil (@ Rs. 100/- per plant)	15,700
Input cost	
• Insecticide	2,000
• FYM	8,800
• Fertilizers	3,300
Total cost	29,800
Second step (from 1-6 month after rejuvenation pruning) Pinching, shoot thinning, pruning of selected shoots (50% of its total length), mulching around the tree, etc. Rs. 30 / plant	4,710
Total cost (1 step + 2 step)	34,510

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Cost of top working

(Spacing 8.0 x 8.0 m, accommodating 157 plants/ha)

Activates	Total cost (Rs.)
Labour cost (First step)	
Heading back of branches from 2.5 to 3.0 m height above the ground level +removal of all the cut materials from the orchard + pasting of cow dung or copper oxychloride on cut portion + pulling out the caterpillar, by inserting iron spoke in the shelter holes, removing the webs and inserting the swab of cotton soaked in monocrotophos and plugging the holes with mud + painting of exposed wood with copper and lime + making basin around the tree + irrigation channel + hoeing and weeding of basin + application of FYM @ 60 kg/basin/plant and mixing them thoroughly with soil (@ 100/- per plant)	15,700
Input cost	
• Insecticide	2,000
• FYM	8,800
• Fertilizers	3,300
Total cost	29,800
Second step (from 1 to 6 month after rejuvenation pruning) Pinching, shoot thinning, budding operation on selected shoots, removal of apical portion after sprouting of buds and mulching around the tree, etc.	7,065
Total cost (1 step + 2 step)	36,865

Technology demonstration in farmer's field

More than fifteen demonstration trials have been conducted in different locations of Pratapgarh, Sultanpur and Allahabad districts of U.P. All the trees responded well to rejuvenation and developed into new canopy. As the technology helped in securing yields in range of 35 to 40 kg/tree in different demonstration plots after

second year of rejuvenation, the farmers rated the technology effective in managing the senile orchards and regaining their production. With the encouraging results at farmers' fields, the rejuvenation technology for aonla standardized by PFDC, CISH sought the attention of farmers as well as Govt. agencies engaged in the promotion of aonla. An extensive programme for rejuvenation is being done through NHM across the country.

Precision Farming Development Centre



Technology demonstrated at farmer's field

The development of rejuvenation technology through topping and hedging of the old dense and uneconomical orchard has been found to be cost effective and is beneficial to the farmers as the orchard gets new lease of life for many years. On the other hand replacing the orchard is not desirable as it is cumbersome, involves a longer gestation period and entails loss

of revenue to the farmers. Therefore, the technique of rejuvenation is a better alternative in this strategy, the farmer is adequately compensated by the wood obtained after the pruning. The resulting shortening of the tree height facilitates interculture operations in the simple way. The inter-space are used to grow suitable intercrops.

