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The aonla (*Emblica officinalis* Gaertn) or Indian gooseberry belongs to family Euphorbiaceae. It is native to tropical southeastern Asia, particularly Indian subcontinent. It is regarded as a sacred tree and known as Amritphal in ancient literature. Besides India, aonla trees are reported to be found in the natural forest of Cuba, USA, Pakistan, Lanka, Malaysia, Java and West Indies. India is principal aonla growing country, and Uttar Pradesh is the leading State in which Pratapgarh (aonla fruit belts), Rai Bareilly, Varanasi,

Jaunpur, Sultanpur, Kanpur, Bareilly, Agra and Mathura are the leading districts for aonla cultivation throughout the country. Currently, aonla is grown over 50,000 ha area in the country with 1.75 lakh tones production. The area under aonla cultivation is increasing rapidly in arid and semi-arid regions of Gujarat, Maharashtra, Rajasthan, Haryana, Andhra Pradesh, Karnataka, Tamil Nadu, Punjab, Himachal Pradesh and Aravali areas. The fruit is the richest source of vitamin C among the fruits except Barbados cherry and

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NA-7 (Neelam)



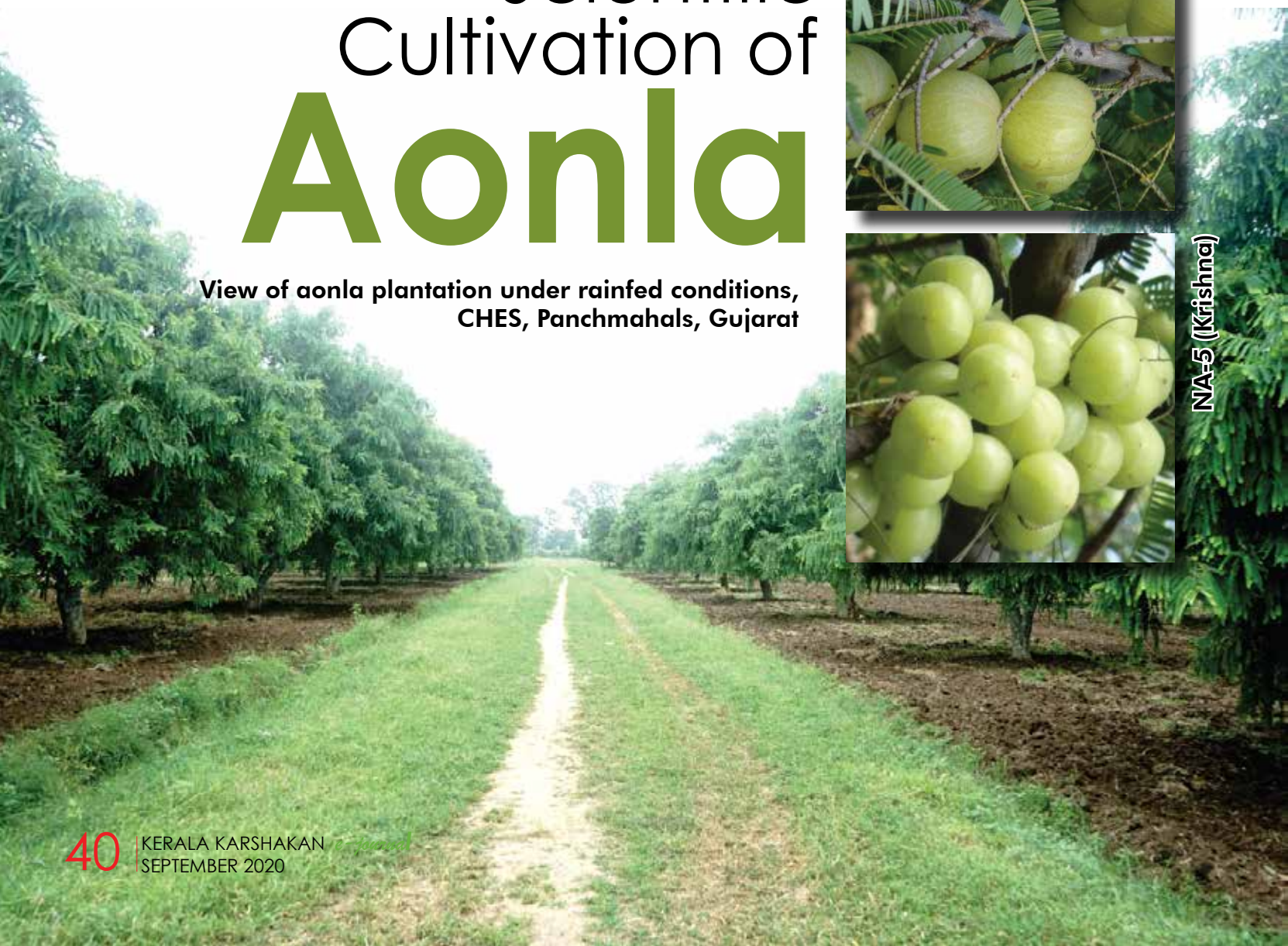
Anand-1



NA-5 (Krishna)

Scientific Cultivation of Aonla

**View of aonla plantation under rainfed conditions,
CHES, Panchmahals, Gujarat**



Banarasi



Chakaiya



NA-10



contains 500-1500 mg ascorbic acid per 100g of pulp. The fruit contains chemical substance known as leucoanthocyanins (polyphenols), which retard the oxidation of vitamin C. Fruit has acidic, cooling, refrigerant, laxative and diuretic properties. Dried fruits are useful in curing chronic dysentery, diarrhoea, diabetes, dyspepsia, cough, anemia and jaundice. The nutraceutical and therapeutic

values of fruits are immense. It imparts health and vitality. It has potentiality for processing into various products like murabba, candy, aonla, shreds, jam, pickles, powder, herbal jam, Chwanprash, shampoo and hair dyes etc.

SOIL AND CLIMATE

Aonla is a very hardy tree and can be grown successfully in variable habitat and agro-climatic conditions. Though aonla is classified as subtropical fruit, its cultivation in tropical, arid and in rainfed semi- arid conditions are quite successful. The natural growing plants can be seen on hills up to 1800 msl. Heavy frost during winter is not conducive for its cultivation. In India, it is grown near sea coast of south India to the foothills of north India. Mature aonla tree can tolerate freezing as well as high temperature of 48°C, but the plants susceptible to frost in winter and sometimes heavy damage due to frost in hot arid ecosystem of western part of Rajasthan. Warm temperature seems conducive for initiation of flower buds. Ample humidity is essential for initiation of fruit growth of dormant fruitlets during July- August. Abrupt changes in temperature during flowering and fruit set adversely affects fruiting in aonla. The young plants should be protected from hot wind during May- June and from frost during winter, at least up to the age of 3-4 years under north Indian conditions. Dry spells result in heavy fruit dropping and delay in initiation of fruit growth. Since aonla is a very hardy plant, it can be grown in light as well as heavy soil. However, well drained

fertile loamy soil is the best for its cultivation. The deep root system, reduced foliage, dormancy of fertilized fruitlet (April-June), coincidence of fruit growth and development with moisture availability period make aonla an ideal plant for arid and semi-arid regions. Aonla can be grown in marginal degraded lands. It can be grown in acidic to saline/sodic (pH up to 9.5, ESP-35 and ECe-6-9 dsm-1) soils.

IMPORTANCE OF CROP

Mostly aonla fruit is sold in domestic market through commission agents. However, with changing consumer preference towards different medicinal and cosmetic products, there is increasing demand of herbal/natural products of aonla within the country as well as outside the country. Aonla is one of the fruits which is being used in various ways, thus fresh aonla and aonla based products are being imported by different countries from India. The major aonla and aonla-based products importing countries are U.K., Germany, Italy, Belgium, Saudi Arabia, Baharin, Hong Kong, Malaysia, Indonesia, Nepal, Pakistan, USA, etc. With the increasing consumer's preference towards herbal/organic products, aonla should be grown organically and its value added products should be popularized in domestic and in foreign market for better revenue generation.

VARIETIES

So far the improvement of aonla has been done through selection only. The varieties of aonla such as Banarasi, Francis and Chakaiya have

their own limitations. Banarasi is shy bearer, Francis is prone to necrosis and Chakaiya bears small size fibrous fruits. The important cultivars of aonla which are being commercially exploited under different edephoclimatic conditions of the country are NA-4, NA-5, NA-6, NA-7, NA-9, NA-10 and Anand-1, Anand-2, BSR-1, BSR-2, Goma Aishwarya and Laxmi 52. The salient features of aonla cultivars are as below:

NA-7 (Neelam)

It is seedling selection from open pollinated strain of Francis. It has semi spreading growth habit, with average number of female flower per branchlet 10.05. It is precocious, profuse bearer and mid season variety. Fruits are medium to large and slightly conical in shape, smooth skinned, semi-translucent, six segmented and easily separated. It is prone to breakage of fruit bearing branches. It is free from necrosis and highly suitable for processing having T.S.S. 9.45° brix, acidity 2.15 per cent and vitamin C 527.00mg/100g of fruit pulp.

NA-4 (Kanchan)

It is chance seedling of Chakaiya. It has tall and spreading growth habit, with average number of female flower per branchlet 7.7. It is heavy and regular bearer and mid season variety. Fruits are small to medium, flattened oblong, six segmented and difficult to separate, flesh fibrous and hard and highly suitable for pickle and powder making. It mature late and is free from necrosis, T.S.S. 9.5° Brix, acidity 2.11 per cent and vitamin C 422.20mg/100g

of fruit pulp.

NA-5 (Krishna)

It is chance seedling of Banarasi from Pratapgarh district of Uttar Pradesh. Tree is semi tall and has spreading growth habit, with average number of female flower per branchlet 3.05. It is a slightly shy bearer and early season variety. Fruits are large, triangular, with red spots on exposed surface; six segmented, easily separated and highly astringent. It matures early, T.S.S. 10° brix, acidity 2.32 per cent and vitamin C 549.20 mg/100g.

Banarasi

It has upright growing habit with three branchlets per node. The average number of female flower per branchlet is 2.56. Fruits are large, triangular and slightly conical at apex, six segmented and easily separated, fibreless and soft. It is shy bearing owing to less number of female flowers and self-incompatibility. It is yearly maturing variety with poor keeping quality. It's T.S.S. 10.50° Brix, acidity 2.23 per cent and vitamin C 402.00 mg/100g of fruit pulp.

Chakaiya

It has spreading growth habit, profuse bearing, average number of female flowers per branchlets 7.03, fruits are small to medium, flattened round, segment six difficult to separate, flesh fibrous and whitish green in colour. It is late in maturity with good keeping quality and highly suitable for pickle making and other processed products. It's T.S.S. 9.5° brix, acidity 2.18 per cent and vitamin C 502.00 mg/100g of fruit pulp.

Francis

It has spreading

growth habit with drooping branches, average number of female flowers per branchlet 4.84, moderate in bearing, fruits are medium, flattened oblong thick at upper side and thin at basin. Segments are six and easily separated, soft and nearly fibrous. Fruit are highly susceptible to necrosis hence not suitable for preserve making. It is mid season variety. T.S.S. 8.24° brix, acidity 1.98 per cent and vitamin C 532.56 mg/100g of fruit pulp.

NA-6

It is selection from open pollinated chance seedling of Chakaiya. It is prolific bearer having 10 female flowers per branchlet. Fruits are small to medium and oval in shape, skin smooth semi-translucent and light green in colour. Flesh is fibrous and semi-hard. Seeds are small light brown in colour. Keeping quality of fruit is suitable for processing. T.S.S. 8.5° brix per cent, acidity 2.11 per cent and vitamin C 422.70 mg/100g of fruit pulp.

NA-10

It is chance seedling of Banarasi locally known as Agra Bold. Tree is semi tall and spreading growth habit. It is moderate bearer having 4.6 female flowers per branchlet. Skin is rough having yellowish green colour, flesh slightly fibrous, whitish green, soft, juicy and highly astringent. Keeping quality good and moderately susceptible to fruit necrosis. T.S.S. 8.5° brix, acidity 2.30 per cent and vitamin C 516.40 mg/100g of fruit pulp.

Goma Aishwarya

Goma Aishwarya is a selection from the tree identified



Traditional packaging in gunny bags

from the large population. It is an early drought tolerant variety and prolific bearer, tree is semi-spreading and fruits are medium in size. It has low fiber content and is suitable for processing and export. Fruit contains 47.00 per cent juice, pulp: stone ratio is 26.65. TSS is 10° brix and vitamin C content is 554.78 mg/100g.

Anand-1

Trees are tall with upright growth habit. It is moderate bearer having 1-3 female flowers per branchlet. Fruits are small to medium, skin slightly rough and

thick, and flesh fibrous and hard. It has medium keeping quality. It is suitable for powder and pickle making.

Anand-2

Trees are tall with upright growth habit. It is moderate bearer having 2-4 female flowers per branchlet. Fruits are small to medium, skin rough with medium keeping quality. Shelf life of fruit is very good. It is suitable for powder making.

BSR-1

This is seedling selection from Tamil Nadu. It is said to be self fruitful, crop round the year,

small size fruit, fibrous and low moisture content, heavy bearer and thus very high demand by Ayurvedic industries.

Laksmi-52

It is seedling selection of Francis from the farmer's field in Pratapgargh district of Uttar Pradesh. Tree is semi-erect type, prolific bearer with large sized fruit. During initial period of fruit growth, the colour is light pink, which disappears at full development.

PROPAGATION AND ROOTSTOCK

Seed sowing and raising of

rootstocks

Aonla has been raised from seeds for long. Seed propagation of aonla has demerits of lacking true to type plants, variable and inferior type of plants and long duration for fruiting. Seeds attain full maturity by February in north India and October in western India. Seedlings are raised from local strain and used as root stocks. For better germination and healthy seedlings, seeds should be soaked in 500 ppm GA3 for 24 hours. Seeds sown in first week of March in nursery bed or in perforated polythene bag (30cm x15cm size) become ready for budding in June-July, which saves about six months, and also helps in effective nursery management than conventional methods.

Vegetative propagation

Of the various methods of vegetative propagation, budding has been found most efficient and successful. Patch budding is being commercially followed for propagation of aonla. Healthy scion bud of desired varieties is used for patch budding during the period from May to September for optimum success. Under rainfed semiarid conditions of Gujarat, in-situ patch budding in May- June before onset of rain, gives more than 94 % success and survival. In- situ patch budding is more efficient and practical followed by soft wood grafting and ring budding in semi-arid region of India. This method takes less number of days for sprouting and had better vegetative growth in terms of length and vigour of sprouted shoot. Plantlet regeneration from cultured endosperm has been

reported when BA (0.2mg/l) and IBA (0.1mg/l) were used in the media.

PLANTING / PLANTING DENSITY

Planting

For establishment of orchard, the pits (1m x 1m x 1m size) are dug during May month at 8 m distance and exposed to hot sun for about a month and then filled with 50 per cent surface soil thoroughly mixed with 20-25 kg Farm Yard Manure and drench the pits with chlorpyrifos (2-3ml/l). In sodic soil, as per GR value, 5-8 kg gypsum or pyrite should also be incorporated in filling mixture. Healthy budded plants with the earth ball should be planted during rainy season, preferably soon after occurrence of rain. For in- situ budding, rootstock should be planted in the already prepared pit at appropriate distance for budding with superior clone to get maximum success and also to avoid mortality of plants during planting particularly in semi-arid region.

TRAINING/PRUNING (CANOPY MANAGEMENT)

Aonla tree does not require regular pruning but in early years for getting proper shape and development of strong frame is necessary for which young plants are trained to single stem up to the height of about 0.75 m and 4-6 well spaced primary branches with fairly wide angle should be allowed to grow at regular space all around the trunk. Plants should be trained to modified leader system. Subsequent pruning consists of removal of dead, infested, broken, weak

or overlapping branches after the harvest of the crop should be followed. Limb breakage in aonla cultivar in NA-7 has been observed at many places due to over bearing, hence for retention of optimum crop load, balanced canopy should be ensured.

High density planting systems

High density planting for obtaining high orchard productivity in short time is a favoured cultural practice, in which improvement in yield/unit area of land utilized by increasing planting density and are based on the need to utilize the allotted space and ensures the maximum utilization of nutrients, water, light and pesticides. There are different high density planting systems, i.e., double hedge row, square, hedge row, pair and cluster system can be applied in aonla cultivation to gain more remunerative effect from orchard. Based on the experiment carried out at Godhra, Economic yield/ha (255.90 q/ha) can be obtained from double - hedge row planting system (260 plants) with an increment of 132.39 per cent over square system of planting (100plants) during 10th year under rainfed conditions of western India. Double hedgerow system is very effective tool to get qualitative and quantitative productivity and economic return per unit area to the rest of the planting system under rainfed condition.

NUTRITION

Manures and fertilizers

The development and growth of the plant, acquisition of optimum qualitative and quantitative yield, proper application of manures and

fertilizers are essential which depends upon the type of soil and age of the plant. A dose of 15 kg FYM, 100 g N, 50 g P and 100 g K should be given to one-year old aonla plants and this dose of manures and fertilizers should gradually be increased every year up to ten years and thereafter, constant dose should be given. It should be given half dose in the month of January before flowering and remaining dose in month of August during fruit development in irrigated conditions. The growth, yield and quality of aonla were influenced by different sources of nutrients. In sodic soil 100-500 gm B and ZnSO₄ should also be incorporated along with fertilizers as per tree age and vigour. Under rainfed conditions, full dose of nitrogen half dose of phosphorus and potash should be applied just after onset of rain and remaining amount should be applied at the end of August. Spray of micronutrients viz., B, Zn, (0.4%) along with lime is also helpful in reducing the fruit drop and improving fruit quality.

Organic farming

For the development of sustainable farming, different organic source of nutrients, viz., biofertilizers (Azotobactor, Azospirillum, PSB, VAM,), FYM and Cakes (neem, mahua, castor and groundnut cake) can be applied which influence the soil physical, biological and chemical properties ultimately leads to the production of qualitative fruits. Among the different organic sources of nutrient FYM + Azotobactor + VAM is found to be more beneficial in reducing the pH, EC, and increasing the hydraulic

conductivity, organic carbon and NPK content in the tree basin. Combination of neem cake, FYM, Azotobactor and VAM has been found beneficial in terms of increasing the soil fertility, soil microbial population, earthworm population yield and quality of aonla fruits under semi-arid ecosystem of Western India.

IRRIGATION

Generally, established aonla orchards do not require irrigation in the normal rainfall and soil moisture conditions. But until the young plants are established, they require irrigation during summer months at the interval of 15 days. Irrigation in bearing aonla plants should be avoided during flowering period (February and March). But irrigation is required after application of manures and fertilizers, and after fruit setting for the development of embryo, if there is inadequate rain and moisture in the soil. Drip system of irrigation has shown promising response where water scarcity is major problem and has been found very effective in rainfed conditions. Plants irrigated through drip at alternate day with 60 per cent wetted area obtain better growth, yield and quality of aonla.

AFTER CARE /CULTURE

Moisture stress constraint can be avoided by the application of mulching practices during growth and development of the plant. For conserving soil moisture, basin of tree should be covered with various organic (straws, husk, grasses, saw dusts, subabool lopping and various kinds of leaf litters and composts) and

inorganic (petroleum products, black and transparent polythene) mulches. Mulching with paddy straw is efficacious in aonla orchard for improvement in soil properties and productivity of aonla fruits. For the salt affected areas, mulches prove to be beneficial in restricting the upward movement of soluble salts which save the plant from the menace of toxic substances.

Aonla being deep-rooted, a deciduous tree with sparse foliage is an ideal plant amicable for intercropping. Plants attain full canopy after 8 years, interspaces between the plant rows and time is unfruitful. Therefore, interspaces left over in the orchard must be utilized by growing intercrops having short lifetime. Cucurbitaceous vegetable crops such as bottle gourd, sponge gourd, bitter gourd, cucumber and pumpkin can be grown successfully in association with plantation under rainfed condition of Gujarat. Aonla plus bottle gourd and aonla plus okra intercropping is most effective in improvement of substantial additional income without adverse effect on main aonla crop yield. Among the fruit crops, guava and karonda can be used successfully as filler in aonla plantation.

Flowering, fruit set, fruit growth and development

Aonla trees start shedding their determinate shoots from December onwards resulting in complete defoliation by the January end. The new flush of flowering shoots begins to appear by the start of February in Western India, which continues till the last week of March. The zygote rests for 120-130 days

and endosperm nucleus for 70-80 days after fertilization (Ram, 1978). After fruit set, the embryo remains dormant and ovary does not exhibit any apparent sign of external growth till June. Fruit however, grows rapidly during rainy season between second fortnights of August to last week of September and completes almost 70 per cent of growth during this period.

HARVESTING

Aonla fruits are harvested after attaining maturity. During harvesting, individual fruit is picked and put in lined baskets carefully to avoid bruising and to avoid spoilage loss. Aonla fruits are damaged quickly at ambient conditions. Maturity of aonla fruits can be judged externally by change in the fruit colour from greenish to whitish green or yellowish green and change in seed colour from creamy white to brown. Apart from its physiological maturity, aonla can be determined on the basis of specific gravity (1.07 to 1.24), fiber content, and TSS/acid ratio (5 to 6). Aonla fruits may be stored up to 30 days on tree itself from the date of maturity without reduction in the quality. The variety Chakaiya and Anand-2 exhibits 7 days, whereas Francis, NA-7 and Banarasi up to 5 days economic life at ambient temperature after harvesting. However, fruits with brine solution can be stored up to 75 days. Fruits of NA-7, Banarasi, and Agra Bold mature by last week of October, while that of Kanchan and Chakaiya are ready for harvest by last week of November. Further, Anand-1 and Anand-2 mature by last week of November under semi-

arid ecosystem of Gujarat.

MANAGEMENT OF DISEASE AND PESTS

Pest management

Aonla is generally free of any serious disease but the insect pest damage the crop considerably, especially when environmental conditions are very conducive. The important pests and diseases and their recommended control measures which are adopted for aonla are mentioned herewith. The suitable, effective and economical IPM strategies for boosting up the production potential of the aonla crop has been developed based on seasonality and their peak period of occurrence. Peak period of activities of the sucking pests (aphid and mealy bug) is February -March and July-August for defoliators and borers. Symptoms and nature of damage are described in brief are as under:

Aphids (*Cerciaaphis emblica*):

Nymph and adults suck the cell sap from tender shoots, leaves, and devitalize the plants. They exude honeydew on which sooty mould develops.

Mealy bug (*Nipaecoccus vastator*):

Nymph and adults suck the cell sap from tender shoots, leaves, and devitalize the plants.

Leaf twister (*Caloptilia acidula*):

The caterpillar on hatching twists the leaf and feed within. In severe infestation plants show sickly symptoms.

Hairy caterpillar (*Euproctis flava*):

The caterpillar on hatching feed voraciously and gregariously on tender leaf and

defoliates the plants. The larvae later on migrate to entire plant and feed on leaves leading to marked defoliation

Shoot gall maker (*Betousa stylophora*):

The caterpillar on hatching enters into the shoots and feed within causing a gall on the tender shoots

Fruit borer (*Virochola isocrates*, *Meridarchis scyroides*):

The caterpillar bore into the fruits and feed within causing premature drop of the fruits during monsoon season. Maximum damage is during July and August.

Bark eating caterpillar (*Inderbela terraonis* Moore): The larvae usually bore at the joint between twig and main stem and forms tunnel straight downward on the trunk. Formation of silken web comprising of excreta of larvae indicates the damage.

Control measures

Orchard sanitation is effective for bark eating caterpillars and borers. Inject kerosene oil or petrol, Dichlorvos and plug the hole with mud for effective control of bark eating caterpillars. Foliar application with Dimethoate (0.05%) at tri-weekly interval controls the overall pests effectively. However, based on the seasonality and their sequence in occurrence, insecticidal schedules involving tri-weekly application of Dimethoate (0.05%) alternatively followed by NSKE (5%) at 10 days interval commencing from fruit set to fruit development has been found significantly better in reducing the incidence of borer in aonla.

Diseases management

Rust (*Ravenaliia emblicae*):

Rust characterized by brown or brown to black, circular to semi circular pustules on fruits and concentric ring on leaves also infects aonla. Spraying with wettable Sulphur (0.2%) or Mancozeb 75 w p (0.2%) manages the disease effectively when sprayed at an interval of 10-12 days beginning from August.

Anthraxnose (*Colletotrichum state of Glomerella cingulata*)

Characterized by circular, depressed, blackish brown spots on fruits with concentric rings having the center bearing dark coloured fungal mass. For managing disease, spray with Mancozeb 75 w. p. (0.2%) or Cuman-L (0.3%), or Captaf (0.2%) or Chlorothalonil (0.2%) or Copper oxychloride 50 w p at 0.3% concentration. Practice deep plugging and healthy cultivation.

Penicillium fruit rot (*Penicillium indicum, P. oxalicum, Aspergillus niger*)

It is a mainly a post-harvest disease characterized by, circular to irregular water soaked blotch with bluish grey fungal mass in the center with sporadic orange-red islands on fruits surface. Collect and destroy the infected fruits. Avoid injury to fruits while harvesting, handling or transporting or storing. Pre harvest sprays (one week before harvesting) with Blitox, Bavistin or KH₂PO₄ and post harvest treatment with 1.5% CaCl₂ and GA₃ (200 ppm) also controls the disease.

Fruit necrosis

Necrosis is a physiological disorder. It has been observed in

aonla fruits, which is associated with deficiency of boron. Incidence initiates with browning of mesocarp, which extends towards the epicarp resulting into brownish black appearance of flesh. It can be controlled with three sprays of borax at 0.6 per cent at 15 days interval starting from the early September.

QUALITY IMPROVEMENT

Intensive research efforts have been generated to enhance aonla production and productivity under different agro-climatic conditions. To improve the quality of aonla production potential, identification of promising genotypes having high percentage of female flowers, prolific bearing, fruits rich in antioxidant, good peel colour, suitability for processing and using them in procreation programme to develop suitable cultivar. From the consideration of the above points, several varieties have been developed which has higher number of female flowers, fruit set and desirable quality attributes. Plantation of high yielding and precocious varieties and minimizing yield gap in initial years are major option for enhancing the productivity of aonla. Fruiting in aonla is also affected by pollinators or pollinizers or both. Fruit quality parameters are also influenced by pollen parents. Problem of unfruitfulness can be minimized by planting more than two varieties and provision of suitable pollinizers, plantation of wind break and spray of chemical like CaCO₃ and Borax.

POST HARVEST MANAGEMENT

The shelf life of aonla fruits can be enhanced by

grading, packaging, pre and post harvest chemical and plant hormones spray. After harvesting, to fetch better price from the market, fruits should be graded according to their size and shape.

A grade fruits are large sized used for murabba and candy making, B grade fruits are small sized, used for chavanprash and trifla, and C grade blemished fruits are used for powder and shampoo making. Under hot semi - arid ecosystem of Gujarat, fruits treated with calcium nitrate 1.5 per cent or GA₃ (50ppm) and kept in perforated polythene bag record the least physiological loss in weight (2.12-16.00 and 2.15-16.34%) and spoilage loss (2.40-15 and 2.50-15.60%) and exhibit 11 days storage life. For packaging, wooden crates of 20-25 kg capacity with polyethylene bags as liners and CFB boxes (10kg capacity) along with newspaper liner is found to be most effective packing material to enhanced shelf life during transportation of fruits at long distance whereas for local market it is collected and transferred in plastic grates lined by news paper.

VALUE ADDITION

Aonla is not utilized as table fruit. But the fruits are commercially utilized for processing industries as murraba, candy, chatni, toffee, shreds, sauce, aonla pulp, powder, juice, laddu, supari, liquor, sherbet, etc.; ayurvedic medicines as chwanprash, trifla, syrup, diabetic powder, aonla powder and in cosmetic industries as shampoo, hair oil, dyes, etc.

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