

Pomegranate

1. Introduction

Pomegranate (*Punica granatum* L.) is an emerging fruit crop of arid and semiarid regions of India under irrigated condition. It is cultivated commercially in the states of Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Madhya Pradesh and Rajasthan in India. In world, India is one of the largest producers of pomegranate and has largest area under pomegranate cultivation. During 2017-18, pomegranate was grown over 2.34 lakh ha with an annual production of 28.45 lakh tonnes and productivity of 12.15 tonnes/ha in India. Maharashtra is the leading state with 68.7 % of the area and 70.2 % of total production under pomegranate (Anonymous, 2015). In India, pomegranate is available throughout the year from January to December and grown in temperate, tropical, sub tropical and arid climatic conditions. Owing to its heat, drought and moisture deficit tolerance capacity, high demand, hardy nature, low cost of cultivation, high yields, better storage quality and therapeutic values area under pomegranate cultivation in India is increasing day by day. It has high medicinal, nutritional value and one of the powerful sources of natural antioxidants. On account of numerous health and nutritional benefits it is known as “super food” or “food medicine”. A large number of value added products such as juices, squash, jelly, anardana and mouth freshener are prepared by processing fruit. The fruit is mainly used as an ingredient in cooling and refrigerant mixtures and in the preparation of juice, concentrates, condiment and pastes (Saxena et al., 1984). The juice is highly nutritious and is recommended for patients suffering from gastric troubles. It contains 16.5% TSS and 0.33% acidity; total sugars, 13.93; reducing sugars, 13.60 and non-reducing sugars, 0.33% and 9.27mg/100g ascorbic acid.

In Rajasthan, it is mainly grown in Jaipur, Ajmer, Alwar, Tonk, Sriganganagar, Pali, Kota, Jalore, Banswara, Sawai Madhopur, Bhilwara, Jhunjhunu and Sirohi districts in 12000 ha area and acreage in Thar desert particularly Barmer, Jodhpur and Jaisalmer is increasing at faster rate.

2. Soil and climate

Pomegranate can be grown on a wide range of soils and tolerates salinity up to 6.00 dSm⁻¹ and sodicity up to 6.78 ESP. Pomegranate can withstand the dry climate and adverse soil conditions prevailing in arid ecosystem. Pomegranate can grow well even in marginal lands with poor fertility and shallow depth. Pomegranate can be grown diverse climatic conditions from tropical, subtropical, arid to temperate regions due to its hardy nature. Interestingly, the best quality fruits are produced in arid regions. It exhibits deciduous nature in the temperate climate but evergreen or partially deciduous under tropical and subtropical conditions, which also depends upon the variety/ genotypes. It grows very well in the semi arid climate where cold winter and hot summer prevails. The tree requires warm and dry climate during fruit development and ripening. The crop withstands heat, drought and moisture deficit. The unique capability of pomegranate is proven from the threshold limit it exhibits for higher (46°C) and lower -12°C temperature.

3. Propagation

Pomegranate is propagated through stem cutting, air layering and recently by tissue culture propagation. There is a growing demand of pomegranate planting material which can not be fulfilled only by conventional propagation methods, thus, mass multiplication of pomegranate through tissue culture is the need of hour. These in-vitro raised plants are initially free from any kind of infection. The in-vitro raised plants of pomegranate are true to type. The mother plant from where cutting, air layers and or explants to be taken must be healthy and free from pest. Cutting should be treated with pesticides for disinfection. Air-layering is commonly used for propagation of pomegranate in Maharashtra, Karnataka and Tamil Nadu owing to high humidity while hardwood cutting is preferred in the rest of India. In air-layering, during rainy season (June-August), the upright branches of 1.0-1.5 cm diameter are girdled (2-3cm) in length and rooting hormone 2000-3000 ppm IBA is applied. Then branches are wrapped with cocopeat or sphagnum moss and covered with a small polyethylene strip. Well rooted layers are detached from the mother plants after 75-90 days. Semi hard wood cuttings of 6-12 month old, 20-25cm length and pencil thickness found suitable for rooting. Pruned wood of winter season can be used, which gives high success rate. Dipping of proximal end of stem cuttings for 5 min. in a solution of 2500 ppm induces fibrous root system, which is necessary for better establishment of plants under field conditions (Rajkumar et al., 2016; Saroj et al., 2008). Plant cuttings in a mixture of cocopeat: and sand (4:1) or cocopeat alone for faster rooting in mist chamber. Well rooted cuttings should be transferred after 45-60 days to nursery bags containing Sand: Soil: FYM (1:1:1). Before transplanting to field keep for 7-10 days in shade for hardening. Perlite + vermiculite 1:1 (v/v) and vermiculite +cocopeat found appropriate alternatives to the conventionally used substrate, i.e., garden soil for the better rooting and establishment of pomegranate cuttings (Rajkumar et al., 2017).

4. Varieties

Large numbers of varieties are grown in different parts of world. In India, Bhagwa is the most popular variety (Fig. 1) owing to its dark red arils and attractive red rind colour, which covers around 80 % of total area and production in India. Earlier, big fruit sized variety like Ganesh was the preferred one, now a days, soft seeded, red peel and aril colored varieties with high juice content are preferred varieties such as Bhagwa and Mridula. In hot arid climate varieties like Jalore Seedless, Bhagwa, Mridula, Phoole Arakta and Ganesh are found promising.

5. Training and pruning

In pomegranate, training starts after 6-8 months of planting to develop structural framework and last up to 2-3 years after planting. The lowest branch should be taken at 30-40 cm above the ground with multi stem training. Pruning is done twice a year to remove dried twigs, branches and maintain balance between vegetative and reproductive growth. Main pruning is practiced just after harvest in winter while light pruning is done at flower regulation during May-June,

which is known as bahar pruning. In severe bacterial blight infected orchards, heavy pruning is done after harvest and remove as far as possible diseased portion.

6. Flower regulation (Bahar treatment)

Pomegranate produce flowers continuously under tropical and sub tropical environments and bear small crop irregularly at different period of the year, which may not be desirable commercially. To avoid this plants are subjected to flower regulation/bahar treatment. The basic objectives of flower regulation in pomegranate is to manipulate the natural flowering and fruiting in such a way that it produce high yield of quality fruits in desired season with sustainable use of farm resources. In this treatment, the irrigation is withheld one to two months prior to the blooming/bahar, which results in shedding of leaves. Ethrel is used (1-2 ml/l) as defoliant to remove leaves (Kumar et al., 2018a). After that trees are medium pruned and the recommended doses of fertilizers are applied and irrigation is resumed. This leads to profuse flowering and fruiting. The fruits are ready for harvest 4-6 months after flowering depending upon variety. In arid and semi arid region, there are three main flowering seasons namely, February-March (ambe bahar) July-August (mrig bahar) and September-October (hasta bahar) (Kumar et al., 2019b). The selection of flowering/bahar to be regulated depends upon the availability of irrigation water, market demand and pest/disease incidence in a given locality. The fruits of ambe bahar are harvested in the month of June to September. As the fruit development takes place during dry months, they develop an attractive colour and quality thus suitable for exports. Similarly due to dry weather, the incidences of pest and disease attack are limited. As a result, ambe bahar is taken only areas having assured irrigation facilities. The mrig bahar fruits are harvested during December to February. Usually this bahar is favoured as the flowering and fruiting period coincides with monsoon season, and the crop is taken without much irrigation. Mrig bahar fruits develop during the rainy season and mature during winter. This bahar is preferred in arid and semi arid region due to limited water availability and climatic condition. The fruits from hasta bahar are harvested during March to April when the availability of the fruits is limited, they fetch high value. Forcing of plants to water stress condition cannot be possible during this period as withholding of irrigation coincides with the rainy season. This leads to poor flowering and fruit set which results in low yield.

a. Withholding of irrigation b. Light pruning c. Application of ethrel d. Dropped leaves on ground e. Defoliated plant f. New foliage emergence g. New twigs h. Flowering initiation i. Profuse blooming

Fig. 2. Process of flower regulation in pomegranate

7. Nutrient and irrigation management

Nutrients influence pomegranate plant growth, flowering, yield and quality. With each harvest considerable amounts of macro and micro-nutrients are being depleted which need to be replenished regularly. Hence, maintaining soil health is necessary for sustainable production. The

requirement of fertilizers varies greatly as per stage of bahar from flowering and fruiting. Time of fertilizer application is May for mrig bahar, October for hasta bahar and January for ambe bahar. Nutrient management should be based on the soil test results. If the dosage of nitrogenous fertilizers is too high the crop becomes too succulent and therefore susceptible to insects. If the dosage is too low, the crop growth is retarded. In pomegranate, most of the root system is distributed in top 50-80 cm of soil and within 1 m of the stem. Manures and fertilizers are applied in ring around the plant at 30-45 cm away from the main stem below the tree canopy at 8-10 cm depth and covered with soil. A five year or above age tree requires 45 kg FYM, 625 g Nitrogen, 250 g Phosphorus and 250 g Potash annually. Micronutrients have ability to improve quality, size, color, taste and earliness, thereby enhancing their market value. They also improve disease resistance and prevent physiological disorders. Micronutrient can be managed by giving two- three foliar sprays during crop season. First spray each of ZnSO₄ @ 0.3%, MnSO₄ @ 0.6%, Boric Acid (17% B) @ 0.6% should be given before flower and bud initiation i.e. 15-20 days after defoliation when growth have come. The second and or third spray of ZnSo₄ @ 0.3% and MnSO₄ 0.6% should be given at 30 to 60 days after peak flowering. Pomegranate is cultivated mainly in arid regions with limited irrigation facilities. The water requirement of plants depends on age, season, location and management strategies. Drip irrigation has great potential due to high water use efficiency and increased yield. Pollination, fruit set and development are most sensitive phases of a plant growth cycle. Water scarcity during fruit development stages results in fruit cracking. Drip irrigation has great potential due to high water use efficiency and increased yield. In addition to water saving (60%), yield can be increased up to 30-35% by drip irrigation. Drip irrigation system with 2-4 adjustable drippers per plant are installed depending upon age of the tree. For one to three year old plants, 2 drippers/plant may be sufficient to provide required irrigation to the plant whereas from fourth year onwards 4 drippers/plant found better. Fertilizers and chemicals are also applied through drip irrigation. For nonbearing trees, about 5-25 litres/plant/day and 20-65 litres/plant/day for bearing trees are needed (Chanadra et al., 2011). Flooding should be avoided which favours wilt and nematode incidence in the orchards. Inorganic or organic soil mulches during dry periods after the rainy season conserves soil moisture and saves irrigation water, creates optimal conditions for plant growth and development.

8. Insect-pests management

In hot arid region of Rajasthan, mite and thrips are major pest causing severe damage while fruit borer, aphid and fruit sucking moth are minor pest in pomegranate.

i. Mites: Mites are red, brown in colour and remain most active during hot dry spell from April to October. Shiny white and brown patches appears on the under surface of affected leaves which may further curl and fall. Leaf give reddish look on severe infestation and pressing of infested leaves with thumb give red colour. For effective management of mite, spray of propargite 57% @ 1ml/l, spiromesifen 240 SC @ 0.5 ml/l or dicofol 18.5 EC @ 2.0 ml/l in rotation and provide irrigation regularly (Kumar et al., 2018 b).

ii. Thrips: Thrips appears on tender shoots and always prefers feeding on new growth of plants. The affected leaves curl upwards and downwards and tip becomes dried. Scarring marks on buds and fruits develop on the fruits. Collect and destroy affected plant parts and dried tender shoots regularly. Avoid intercrops which act as alternate hosts like chilli, onion, garlic, brinjal and tomato in pomegranate. Spray imidacloprid @ 0.4 ml/l or acephate 75 SP @ 1ml/l on observing the symptoms.

iii. Fruit borer: The adult males are glossy bluish and brownish violet and females have conspicuous orange patch on the forewings. The adult female lays eggs on flower bud and young fruits. Infested fruits have holes with blackish brown excreta of larva on surface. The infected fruits start rotting, produce foul smell and drop down. For management of fruit borer, collect and destroy the infected fruits. Avoid growing of alternate host plant like guava, aonla and tamarind in the pomegranate orchard. Cover fruits with bags to distract the butterflies as well as larva. During flowering spray neem seed extract 50g/l and spray deltamethrin 2.8 EC @ 1.5 ml/l or malathion 50EC @ 12ml/l or azadirachtin 1500 ppm @ 3.0 ml/l at 10-15 days intervals up to harvesting.

iv. Aphids: It infests new flush of pomegranate. Whitish green aphids appear on foliage, buds, flowers and fruits. Sticky honey like semi solid substance found on leaves which gives sooty mould and honeydew appearance. High humidity during rainy season favours the multiplication of aphids. Do not grow ornamental plant like rose which are good host to aphids. Spray imidacloprid 0.3 ml/l, thiamethoxam @ 0.4ml/l or dimethoate 1.5 ml/l when new shoots emerge.

v. Fruit sucking moth: Fruit sucking moths remain active from August to October and only attack the fruits of Mrig bahar crop of pomegranate. Adult males and females of moth penetrate the fruits at night time. Damaged fruits start rotting due to secondary infections from different fungi and bacteria. Punctured holes on fruits with oozing fruit juice can be seen and infected fruits drop down. For management, avoid taking mrig bahar crop in affected areas. Destroy alternate hosts like Lantana camara and castor in and around the field. Keep poison baits (95% jaggery + 5% malathion) in the big flat earthen pots and install in field.

vi. Termite: The worker termites damage roots and trunks of the pomegranate plant and move upward by making the tunnels. Soil tunnel on tree trunk on scarring shows the damage caused due to feeding of bark. Field should be kept clean and free from plant debris. All the dried wood should be regularly collected and removed. Scrap the soil tunnel on trunk and spray the trunk with malathion (1.5 ml/l). Application of neem cake (1-2 kg/plant) followed by irrigation, helps to drive away the termites. Drench the soil with chloropyriphos (2ml/l) around the base of the plant. Train the plant in multiple stem (3-5) to avoid yield losses by termite damage.

vii. Bird damage: Birds particularly parrot and sparrow cause severe damage to pomegranate fruits after 2-3 month of fruit set when aril start developing. The type of control method will

depend on a number of factors like crop growth stage, damage patterns and species behavior etc. For small orchard and isolated trees, netting with anti bird net are found effective. In most cases, netting is spread directly over the plants through support by iron frame. It has a high initial cost, but effective in pomegranate due to high cost of produce. Bird scaring ribbon and sound makers also used to keep birds away from crops. Covering of fruit with bags is also found effective against bird damage.

9. Harvesting and post harvest management

The maturity period for commercial cultivars depends on variety and season. The fruit of cultivar Jalore Seedless is harvested after 140-150 after full bloom while after 170-180 days in cultivar Bhagwa. A TSS/acid ratio of 25-40 in general is good index of maturity of pomegranate cultivars under Indian conditions. At maturity pomegranate fruits give a metallic sound on tapping. The fruits attain a characteristic rind colour upon maturity i.e. 75-80% red colour in case of red coloured varieties. The plant starts bearing from second year onwards; it's not advisable to allow setting fruit up to 2 years. Allow flowering and fruit set only from 3rd year onwards to build up the vigour of the plants for sustainable production. The pomegranate fruits should be harvested only after attaining maturity on the tree as it is a non-climacteric fruit. The flowering and harvesting period of pomegranate varies for different flower regulation periods. Usually the harvest commences in December-January and extends up to June-July depending on the bahar. The severity of different physiological disorders like fruit cracking, sunscald, aril browning is maximum in fruits of ambe bahar crop during April-May. After harvest, the fruits collected in plastic crates should be immediately pre-cooled to remove the field heat. Then, the fruits are graded and packed in CFB boxes. Grading is done to obtain a reasonable price in the domestic or export market. Cracked, damaged, diseased and infested fruits should be removed.