

Kinnow Mandarin enriching citrus industry

Kinnow mandarin, a hybrid between King orange and Willow leaf mandarin which could not become very popular in the USA, has revolutionized the citrus industry in India, Pakistan and Bangladesh owing to its profuse bearing, attractive orange-coloured fruits, high juice content, better yield and quality. The vitamin C content is 31mg/100ml juice. In India, it is commercially grown in the arid and semi-arid regions and has adapted very well in Sri Ganganagar district of Rajasthan, parts of Punjab, Haryana and foothills of Himachal Pradesh. In the recent past, due to its profuse bearing, high quality fruit and higher economic returns besides the traditional areas, there had been a rapid expansion in area under Kinnow around NCR region of Delhi, Western Uttar Pradesh, Nagpur and Akola regions of Maharashtra including tribal tracts of Chhattisgarh and Madhya Pradesh. The Kinnow industry in India can be further revolutionized by refinement of production technologies such as selection of appropriate rootstocks, quality planting material, irrigation scheduling, integrated crop management practices and post harvest handling.

CITRUS is the third most important fruit crop of India after banana and mango. It occupies an area of 1.078 million ha and share 12.5% of total fruit production. Among citrus, mandarin occupies 4.6% of area and share 3.6% of total fruit production.

Kinnow mandarin, the first generation hybrid between King (*Citrus nobilis* Lour) and Willow leaf (*Citrus deliciosa* Tenora) developed by H.B. Frost at the University of California, Citrus Experiment Station, Riverside, Davis (USA) in 1915 and released for commercial cultivation during the year 1935. The developed hybrid could not make a breakthrough in USA, but it was introduced by different citrus growing countries of the world and it has revolutionized the citrus industry of India, Pakistan and Bangladesh owing to its beautiful golden-orange fruits, higher productivity and economic returns. Sri Ganganagar district of Rajasthan excels in Kinnow production. Besides Ganganagar, Kinnow is also commercially cultivated in Punjab, Haryana, NCR region of Delhi including Dhaulakuan district of Himachal Pradesh. Its cultivation is also being gradually extended to the non-traditional areas of Chhattisgarh, Madhya Pradesh and Uttar Pradesh.

Nutritional value of Kinnow mandarin

Physiochemical	Quantity/100g
Average vitamin C (mg/100ml juice)	31.0
Calcium (mg/100ml)	40.0
Iron (mg/100ml)	0.4
Phosphorus (mg/100ml)	18.0
Average TSS (%)	11.5
Average acidity (%)	0.8-0.9
Average TSS/acid ratio	12.0-14.0:1



A view of kinnow mandarin on trees

To achieve optimum productivity, irrigation water is being used in excess, posing salinity threat due to rise in groundwater table. Climate change and the continuing atmospheric carbon dioxide rise are also expected to have significant impacts on conditions affecting Kinnow industry.

CULTIVATION

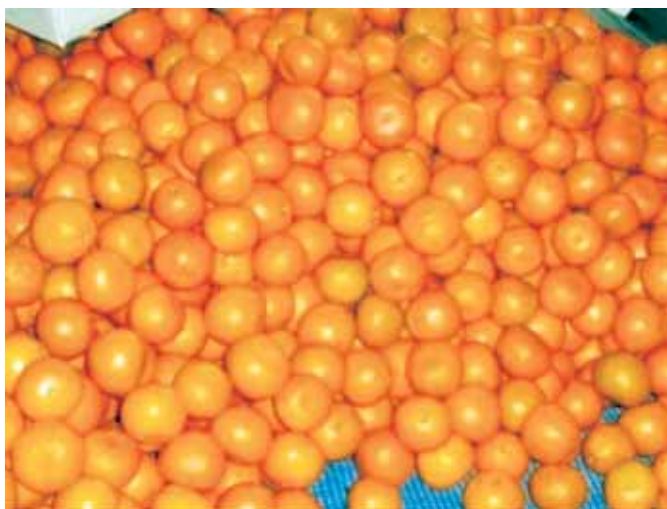
Soil and Climate

Kinnow can be grown successfully in a temperature range of 10-35°C. It has the ability to withstand soaring temperature as high as 40°C during summer and 0°C during winter. Hot winds and excessive heat during flowering and fruit set are highly detrimental for fruit bearing and cause fruit drop and sunburn of the fruit. Planting of wind breaks around the orchard have been found effective in minimising the problem. Low humidity favours colour development. Sites having well drained

clay-loam soils with 6.0-7.5 pH are ideal for its cultivation. The crop is sensitive to salt concentrations in the soil and hence optimum care should be taken to determine the suitability of the rootstock for the area being grown.

Rootstocks

To achieve optimum productivity, appropriate rootstock-scion combinations are crucial. Troyer citrange has been found highly promising to induce dwarfing in Kinnow and hence, recommended for high density planting at 2×2 meter (Approximately 3000 plants/ha) and allowing multiple shoots to come out above the bud union. Plants raised on this rootstock are precocious and start bearing after 3 years of planting in the field with an average yield of 60 to 80 fruits/plant. *Karna Khatta* and *Sohsarkar* are semi-vigorous and vigorous types of rootstocks for Kinnow. With the use of these rootstocks, the availability of Kinnow fruits can be extended for a longer period i.e, from end of November to mid of January. Likewise in areas where irrigation water salinity is ≥ 50 mM NaCl, *Jatti Khatti* and *Soh Sarkar* can be used as rootstock. *Karna Khatta* rootstock can sustain drought and can be a better rootstock for areas having limited irrigation.



either *in situ* or in poly bags of 12cm×30cm size. A bottleneck type of bud union configuration has been seen in many Kinnow orchards, leading to early decline and poor quality of fruit therefore budding should be carried out on desired rootstock and at an appropriate height.

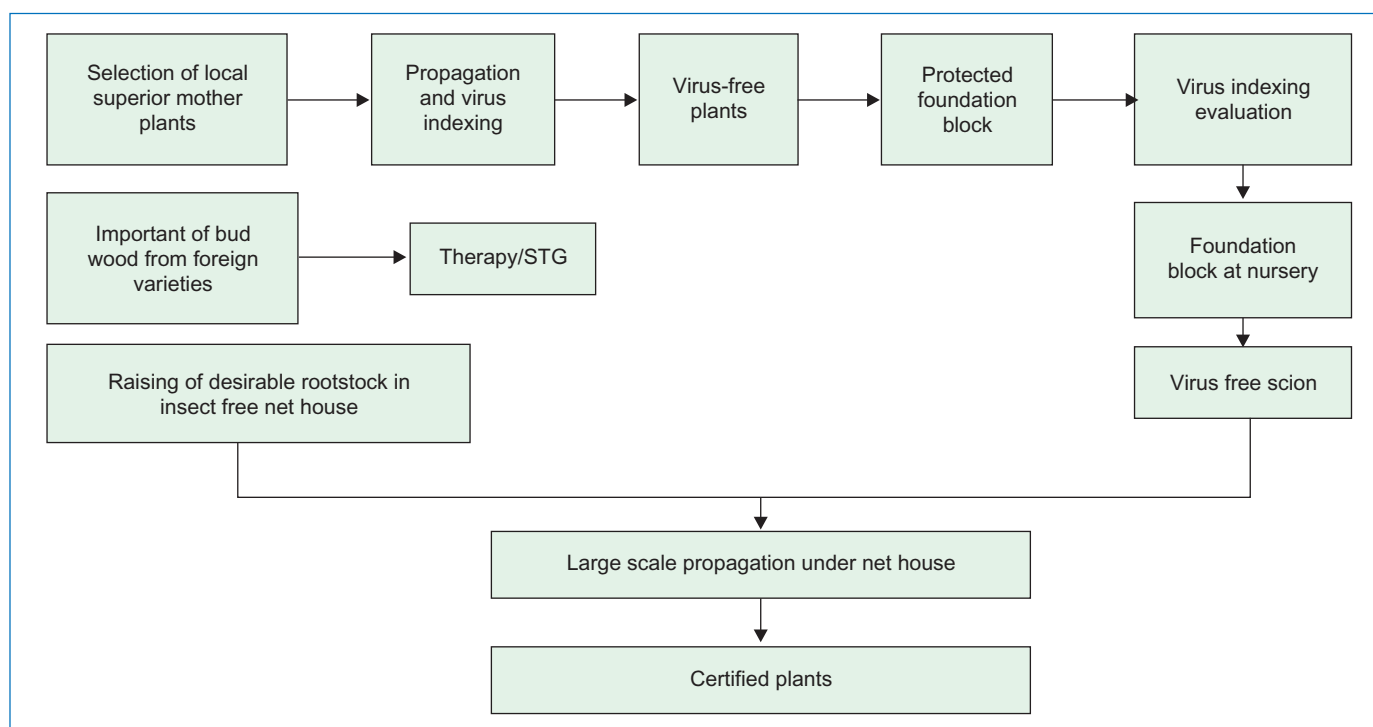
In recent years, tremendous loss in yield and quality of Kinnow has been observed due to various bacterial, fungal and viral diseases. Since vegetative parts such as bud-wood are used as planting material for citrus, these pathogens can be transmitted indefinitely either independently or simultaneously. Use of certified virus and other graft transmissible pathogens-free mother plant is the most important method to manage these pathogens. Selection of elite mother plants followed by shoot tip grafting *in vitro* and virus indexing can effectively be used to get healthy planting material.

Manures and Fertilizers

A dose of 30 kg farmyard manure, 75-100g N, 50g P, 75-100g K and 35g ZnSO₄ should be given to non-bearing plant. The full grown up trees require 80 kg farmyard manure, 600g N, 400g P, 600g K and 250g ZnSO₄. Farmyard manure should be applied during July-August while 1/3 of N, P and K may be applied during the month of February, April and August. Half dose of ZnSO₄ may be given during February and April. The manure and mixture of fertilizer should be spread under the canopy of plants

Planting Material

Kinnow mandarin is commercially propagated by budding onto desired rootstock during August-September and February-March when there is sufficient cell sap flow



Bud wood certification system



Harvested kinnow mandarin



Kinnow mandarin packed in box

and be incorporated in the soil. The soils of arid region are poor in organic matter, low in nitrogen, medium in phosphorus and medium to rich in potassium, hence the dose may be modified as per the regional recommendation.

Irrigation

The irrigation frequency depends on the soil, climate, rainfall and age of the plant. Light irrigation with high frequency is beneficial. Diseases like root rot and collar rot occur in flooded conditions and hence flooding should be avoided. Irrigation should be given through drip system at crucial stages of crop growth. The water requirement of a Kinnow plant is maximum between April-June. On an average, a three year old plant should be applied with 23.0, 30 and 32.0 litres of water every alternate day through drip during the months of April, May and June. Likewise for a seven year old plant, 100, 120 and 142 litres of water every alternate day may be given during the months of April, May and June.

Harvesting and Post-Harvest Management

Kinnow starts commercial bearing after 4 to 5 years of planting. Being a non-climacteric fruit, it should be harvested at full maturity during January-February when TSS/Acid ratio is between 12:1 or 14:1. On an average, 400-450 fruits can be harvested with an average yield of 70-80 kg/tree. The harvested fruits should be washed with water followed by a chlorine wash (100-150 ppm). For export purposes, proper grading and waxing should be done. Precooling at 5-6°C at 90-95% RH and air circulation ratio of 100:200 and cold storage at 5-6°C at 85-90% RH are prescribed for export.

Vented plastic crates (55cm×35cm×30cm) are being increasingly used as containers for bulk handling of Kinnow mandarin in field and packing houses, replacing traditional bamboo containers. Mechanised harvesting and handling of fruits is being practiced in Punjab.

Since fruits of Kinnow are heavier in weight, they contain more juice. The medium sized fruits are better for juice recovery. The stored fruits yield 46-55% juice.

The TSS also increases with storage, while acidity decreases. Thus, Kinnow can be utilized for juice processing for a longer period as storage both at ambient temperature and refrigerated conditions are possible for different periods (20-55 days). Since the seeds in Kinnow are more, this aspect needs to be researched for quality extraction of the juice having lower limonin content.

Plant Protection

Citrus psylla, white fly, leaf miner, mite, mealy bug and fruit fly are some of the major pests of Kinnow. For the control of psylla, white fly and leaf miner, Confidor 17.8 SL (Imidacloprid) @ 0.5ml/L of water should be sprayed at monthly interval between February-July. For mites, Fenzaquin 10 EC @1000ml/500 litre of water should be sprayed between May-June as a preventive spray. Mealy bug can be controlled by spraying Carbosulphan @1.5ml/10 litre of water.

Among diseases, *Phytophthora* is a major problem, particularly in orchards which are subjected to flood irrigation. If appropriate care is not taken, it results into the death of trees within a very short period of time. For its control, the pit should be drenched with Ridomil MZ (27.5g) + Bavistin (10g) per 10 litre of water particularly during June-July. Bio control agents such as *Trichoderma* have been found very effective if applied along with FYM.

Control of Post-harvest Diseases

Post-harvest decay of Kinnow mandarin due to infection of various pathogens (*Botryodiplodia theobromme*, *Colletotrichum gloeosporioides* and *Alternari acitri* as pre harvest pathogens) can be controlled, if proper disease control packages are adopted. Three pre-harvest sprayings (45, 30 and 15 days before harvesting) with Benzimidazole covering the whole canopy control stem end rot disease.

Quality standards for export

Fruit size	-	60 mm
TSS	-	11-13° Brix
TSS:acid	-	12-14
Skin colour	-	Golden yellow
Firmness	-	2.95-3.5 kg/cm ²

For further interaction, please write to:

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