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Rejuvenation of Citrus in Arunachal Pradesh

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ABSTRACT

The area under citrus in India is 1.078 million ha with a production of 11.14 million tonnes and average productivity of 10.3 tones/ha. The traditional mandarin growing areas of Arunachal Pradesh experience humid subtropical climate with high rainfall in monsoon (summer) and low temperature during winter months. Common rootstocks used for budding of mandarin oranges are Trifoliate Orange, Kharna Khatta, C. latipes and C. jambhiri.

Long spells and Heavy rainfall, Soil erosion, Lack of desirable planting materials, Lack of application of amendments in acidic soils, Nutrient deficiencies, Lack of proper orchard management, No control of insect pests and diseases, Lack of marketing facilities, Lack of processing and Lack of extension support are the major problems for citrus decline in the state. Strategies like proper site selection, Suitable method of planting, disease free elite planting material, Soil and nutrient management, Proper orchard management, Management of insect-pests and diseases and Extension services can be adopted for rejuvenation of old orchards. A suitable road map covering integrated approaches can be formulated for management of decline orchards.

Key words: *Decline orchards, Insect-pests management &Road map.*

INTRODUCTION

In India, on production basis; Andhra Pradesh ranks first with 1913.4 million tonnes followed by Maharashtral with 1761 million tonnes and Madhya Pradesh with 1240.8 million tones while punjab with 1044.2 million tonnes ranks 4th position (NHB data base 2013-14). Commercial Citrus fruits of the trade include sweet orange (*Citrus sinensis* Osbeck), Mandarin (*Citrus reticulata* Blanco), limes (*Citrus aurantifolia* Swingle), lemon (*Citrus limon* (L) Burm.f), grapefruit (*Citrus paradisi* Macf.) and pummel (*Citrus grandis* (L.). India have 1.07 million ha area under citrus, with a production of 11.14 million tonnes with 10.3 tonnes/ha productivity.

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Total mandarin production in India is 3.43 million tonnes with 0.33 million ha area and 10.40 tonnes/ha as productivity while limes/lemons have occupied an area of 0.28 million ha with 2.83 million tonnes production and 9.9 tonnes/ha productivity. Of the various types of citrus grown in India mandarin, sweet orange and lime/lemon are of commercial importance[3].

The Kinnow mandarin is commercially successful in north Indian states like Punjab, Haryana and Rajasthan falling under subtropical climate with distinct winter season. Similarly, the traditional mandarin growing areas of North-eastern hill states experience humid subtropical climate with high rainfall in monsoon (summer) and low temperature during winter months. This is very common interest because of it's high content of vitamin C and for preparation of refreshing juice, pickles, squash, cordials, essential oils and other by-products.

The North Eastern Hill Region of India is one of the richest centre of genetic variability with 136 horticultural species growing in the region. This region has been identified as the Hot spot of mango, banana and citrus. This region is centre of *C. reticulate, C. aurantifolia, C. megaloxycarpa, Citrus indica, C. assamensis, C. latipes, C. ichagensis, C. macroptera, C. aurantium, C. jambhiri, C. grandis, C. limon* and *C. karna*[2]. Major citrus growing states North East India along with area, production and productivity is mentioned below[4] (Table 1).

Table 1: Citrus Belts of North East India:

State	Cultivars	Major Belts	Area (,000 ha)	Production (,000 tonnes)	Productivity (t/ha)
Arunachal Pradesh	Khasi mandarin	West Siang District, Lohit District	19.6	24.2	1.6
Assam	Assam lemon	Tinsukia, North Cachar Hils, Nowgaon, Jorhat, Barpeta, Dibrugarh, Kamrup, Lakhimpur, Sonitpur, Khetri	14.4	114.9	8.2
Manipur	Oranges, Lemons	Tamenglong, Tapaimukh and Jiribam, Ukhrul, Churachandpur, Senapati	2.2	9.0	4.1
Meghalaya	Mandarin	Southern and western slopes of Khasi hills Mawsynram and Cherrapunjee	7.3	32.9	4.5
Mizoram	Mandarin, Oranges	Kolasib, Tawitaw, Aizawl, Thing dawal	8.8	33.5	3.9
Nagaland	Mandarin	Longnok, Mokochung, Tuensang, Wdokha, Khonsama	1.4 5	5.3	3.8
Sikkim	Mandarin	East district, South district	6.8	6.0	1.13
Tripura	Mandarin	Dharmanagar, Kumarghat, Jampui Hills, Amonpoi, Vhangmon	2.7	44.5	3.5

Growth and Production of Identified Citrus Species

Mandarin Orange (*Citrus Reticulata* Blanco)

Approximately, 25,000 ha are under mandarin orange cultivation in Arunachal Pradesh. A subtropical to sub-temperate climate and evenly distributed rainfall about 2000-3000 mm throughout the years are required the state for successful cultivation of Mandarin. An average temperature of 10-25°C along with cool summer in the region, favours quality fruit production for supply from November to February.

Sweet Oranges (*Citrus Sinensis* Osbeck)

Thick skinned oranges are grows well in the foot hills and valley of Arunachal Pradesh. Sweet Oranges are good for distance transportation. Among 14 varieties of Sweet oranges tested, Soh-niang riang has been found highest yielder of fruits (450 Nos.) followed by Valencia Newton (353.3), Exelier Malta (329), Daccus Malta (273), Malta Orange (266) and Rubi Blood Red (246.6). Individual fruit weight was found highest in Washington Malta (223 g) followed by Vanila Malta (201 g) and Majurica Malta (192 g). TSS: Acidity ratio was highest with Mousambi Australia (5.18) followed by Majurica Malta (5.0), Whittawar Malta (4.96) and Valencia Newton (4.91).

Acid Lime (*Citrus Aurantifolia* Swingle)

Thinned skin and become yellow after ripening. The pulp is sour, greenish white in colour and useful for making curries and pickles. Acid limes grows well around low hills (1000 m m.s.l.) in state with special care against bacterial canker and powdery mildew diseases. A chance seedling of Acid Lime collected from Pangin area of East Siang District has been found promising for low to mid altitude of state.

The characteristics of above mentioned selection is described below:-

Parameters	**Values**
Plant height	3.7 m
Canopy spread	342 cm x 352 cm
Period of flowering	January to September
Period of fruiting	March to November
Fruit yield/plant	800
Fruit weight	50 - 69 g
Juice content/fru	25 - 32 ml
Rind thickness	2.4 - 3.0 mm
Acidity	7.5%

Assam Lemon (*Citrus limon*, Burm)

This is very popular variety of lemon and is resistant to vagaries of climate and it can be grown commercially in subtropical humid climate of state. The fruits of variety are oblong, medium large in size, highly juicy and can be used commercially for preparation of juice, cordial *etc*. The physiochemical characteristics of fruits of Assam Lemon, grown in low to medium hills of Arunachal Pradesh are given below:

Parameters	**Values**
Fruit weight	120 g
Fruit size	9.5 cm x 5.8 cm
Peel weight	50 g
Juice content/fruit	39 ml
T.S.S.	6.5 ° Brix
Acidity	5.6%
Period of fruiting	June to November

Kinnow:

This is a hybrid between King Orange and willow leaf Mandarin and grows well in low to mid hills ofstate. Fruits are bright orange in colour, oval, glossy and slightly tight skinned. Kinnow is dwarf in stature and can be used in high density planting. Physiochemical parameters of fruits of Kinnow grown at low hills of region are described below:

Parameters	**Value**
Average fruit weight	130g
Average fruit size	6.5 cm x 5.4 c
Average No. of juice vesicles	11.0
Average No. of seed/fruit	16
Juice content/fruit	58 ml
T.S.S.	8.3 Brix
Acidity	2.04%
Period of fruiting	November to March

Table 2: Major Rootstocks used For Citrus propagation and Their Characteristics

Name	**Fruit weight (gm)**	**Fruit Diam (cm)**	**Fruit length (cm)**	**Juice/ fruit (ml)**	**Acidity (%)**	**TSS (oB)**	**No. of Seeds**
C. latipes	285	8.4	7.9	50	3.45	7.4	4.2
Kharna Khatta	309	8.7	9.6	37.7	5.24	4.7	3
Kamla Australlia	352	8.9	9.4	57	5.12	6.7	2.5
Trifoliate Orange	40	4.2	4.4	6.67	5.28	12	17.6
C. jambhiri	140	6.4	6.5	13	3.96	7.8	3.1

PRODUCTION TECHNOLOGY

Selection of Planting Materials

For vigorous and promising stocks, it essential that due care should be given to the quality vigour of plant. Healthy, fairy old, true to the type heavy bearing trees with standard quality of fruits should only be selected as mother tree for propagation. Tree should also be free from pests, mycoplasmas and virus diseases.

Propagation

Citrus is mainly propagated through seeds, air layering and uprooted planted propagates. Although citrus may be propagated by cutting, grafting or budding, various species are propagated by different methods.

Propagation through Seeds

Seed should be obtained from healthy and disease trees and from well developed mature fruits, all seeds poorly developed immature fruits should be discarded. In general large seeds show higher and quicker germination and better growth than the small ones.

Vegetative Propagation

Cutting

So many species of citrus viz. Assam lemon, lime *etc.* can be successfully raised from cutting and it is very useful method of propagation. Cutting should be taken 10-25 cm long and 2.5 cm thick from middle portion of one year old shoots. Cutting treated with 500 ppm IBA gives best result. July month is the best time for planting of cutting.

Air Layering

Very common in India, Acid lime, kinnow and sweet lime are commonly propagated by this method. Long, one to two year old shoots are suitable for air layering.

Budding

This is very popular practice to propagate planting materials through vegetative system. In mandarin orange, trifoliate orange, carrizo Citrange, Troyer Citrange Tanyum (Local), Cleopatra mandarin, *Citrus volckemariana*, rough lemon, *C. latipes*, have found to be promising rootstocks. Rough lemon, Cleopatra mandarin and Rangpur lime are suitable for deep soils whereas, trifoliate orange suitable for medium to shallow soils. Nursery can be raised with the seed extracted from the healthy rootstock. It takes about 12-15 months to attain pencil thickness which is the proper stage of budding. Budding can be done in the month of March and August to September when apical tissue is in active growth stage. T-budding is the most common and popular method for propagation of citrus.

Performance of Budded Mandarin Oranges

Among different combination with two types of mandarin oranges (Khasi Mandarin, Hill Mandarin) and three species of rootstock.

(Tanyum, *C. latipes*, Rough lemon), *Citrus latipes* + Hill mandarin attained maximum plant height (2.48 m), stock diameter (5.4 cm) and no. of branches (14 cm) (Table 3)[1].

Table 3: Growth Performance of Budded Mandarin Plants (After 4 Years)

Treatments	Plant height (cm)	Canopy spread (cm)	No of branches/plant	Stem diameter (cm)		No of Fruits
				Scion	Stock	
C. latipes + Hill mandarin	248	138 x 165	14	5.1	5.4	25
Khasi mandarin + Rough lemon	209	113 x 127	7	4.3	5.0	8
Tanyum + Khasi mandarin	196	142 x 144	11	4.3	5.2	19

Table 4: Physicochemical Characteristics of Budded Mandarin Oranges

Name	**Fruit weight (gm)**	**Fruit Diam (cm)**	**Pulp wt (G)**	**Juice/ Content (ml)**	**Acidity (%)**	**TSS (B)**
C. latipes + Hill mandarin	114	6.1	81.9	43	1.58	9.7
Khasi mandarin + Rough lemon	96.2	5.1	62.7	46	1.38	7.61
Tanyum + Khasi mandarin	104	6.9	80.2	47	1.85	9.78

Selection of Site

The hill slopes having good drainage and fertile soil are suitable. The soil depth of 1m is necessary. Planting in southward directions ideal to get sufficient sunlight

Layout and System of Planting

square systems is suitable maintaining row to row and plant to plant distance of 6 x 6m whereas on hills slopes, contour bunds can be made at a distance of 5.5 to 6.0 m depending upon the gradient and then half-moon terraces can be made between the two contour bunds at a distance of 6m. The pits should be filled with top soil mixed with rotten FYM @ 12 kg/pit and raised the level of pit to a height of 15-20 cm from ground level.

Time and Method of Planting

Rainy season (May to July) is ideal time.

CULTURAL ASPECTS

Fertilization and Manuring

Citrus, does a nutrient love plants and 15 elements have been known to be essential for proper growth of mandarin orange. Fertilizers should be given in 2-3 doses and one third of the total nutrient requirement may be applied in organic form and other two third in inorganic form.

Table 5: Schedule of Manuring and Fertilizer Application

Type of Manure/Fertilizer	**Time of Application**	**Age of Plant**					
		I year	**II Year**	**III Year**	**IV Year**	**V Year**	**VI Year Onwards**
FYM (Kg)	February	5	10	15	20	25	30
Urea (g)	March	70	135	200	270	285	335
	September	70	135	200	270	285	335
SSP (g)	March	200	300	400	500	600	800
	September	200	300	400	500	600	800
MOP (g)	March	70	135	170	200	200	300
	September	70	135	170	200	200	300
Lime (Kg)	February	2	2	2	3	3	3
	September	2	2	2	3	3	3
Micronutrient	A mix of 100 gm each of zinc sulphate, magnesium sulphate and manganese sulphate, 80 gm copper sulphate, 20 gm borax along with 100 gm lime dissolved in 20 litre of water should be sprayed twice in March- April and Sept- Oct.						

(Source: Improved Production Technology of Khasi Mandarin, Technical bulletin, ICAR- Basar, Arunachal Pradesh).

Training and Pruning

A single stem up to a height of 40-50 cm should be trained from the ground level and there after 4-6 well shaped branches are to be grow. Prune water sprouts, root stock suckers and dried branches. Cutted ends should be pasted with Bordeaux paste.

Intercropping

Leguminous crops like pea, cowpea, french bean, green gram, black gram, less exhaustive seasonal vegetables, pineapple and papaya can be grown as inter crops to improve the fertility and physical condition of orchard soil. On hill slopes two rows of pineapple can be planted just below the contour bunds at a spacing of 60 cm from and 40 cm from plant to plant.

Rejuvenation of Declined Orchard

A twenty to twenty five years old orchard of Khasi mandarin have been identified and two trials laid out separately on rejuvenation (Top working) with the following schedules.

1. Khasi Mandarin

Top Working Heights

Primary Branch Control

0.5 m

1.0m

1.5m

Table 6: Rejuvenation of Khasi Mandarin

Treatments	Plant height (cm)	No of branches	Canopy Spread (cm)	Shoot Circumference (mm)	Shoot Length (cm)	No of Shoots
Control (without pruning)	583	13	411 x 426	81	5.89	182
0.5 meter	314	6	124 x 139	81	3.16	14
1.0 meter	368	5	167 x 194	71	2.69	64
1.5 meter	421	6	201 x 217	68	3.24	86

Table No7: Physicochemical Characteristics of Dehorned Khasi Mandarin Fruits

Treatment	Fruit weight (g)	Fruit Size (cm x cm)	Juice content (ml)	Pulp Weight (g)	Acidity (%)	T.S.S (°B)
Control (without pruning)	72.61	5.21 x 4.18	40.31	54.0	1.10	9.21
0.5 meter	81.38	5.11 x 3.98	54.78	60.28	0.86	9.10
1.0 meter	76.44	5.02 x 4.18	49.27	71.98	0.89	9.24
1.5 meter	106.57	5.85 x 6.02	58.37	97.49	1.14	10.30

Out of four treatments (pruned), primary branch pruned produced maximum number of fruits (182) followed by pruning at 1.5m height (Table 4). In terms of quality, fruits from pruned trees were better than control (unpruned) (Table 12). Pruned plants produced fruits with higher quality viz., larger fruit size, weight, more pulp weight, juice content, lower acidity over control but primary branch pruned treatment gives higher TSS than unpruned control and others.

Major obstacles:

Erosion of Soil: Steep slopes (60-70%), causes heavy soil loss by surface run off due to heavy rain. It causes loss of plant nutrients and exposure of the roots.

Heavy Rainfall: It favours development of mosses, lichens and fungal pathogens. It cause damage during flowering and fruit setting.

No Amendments in Acidic Soils: It has been reported that citrus trees perform well in soils having pH range of 5.5 to 6.5 and it causes deficiency of boron, zinc and iron. Farmers do not use any type of amendments for such type of soils.

Nutrient Deficiencies: Deficiency of Zinc, magnesium, phosphorous, boron, calcium, molybdenum *etc*. cause less yield and dieback.

Lack of Promising Planting Materials: Old mandarin orange plantations are of seedling origin and budded plants on desirable rootstocks are never planted on hill slopes or in the valleys. The disease free, true to type, genuine planting materials is lacking in the region. Acclimatization of tissue cultured plantlets is a slow and difficult process.

Lack of Marketing Facilities: There is no organized market in the state and the farmers used to get low return by selling the perishable produce at throw way prices to middlemen.

Rainfed Cultivation: Dry spells during rainy and winter season, causes shortage of soil moisture and due to that dieback of young plants occurs.

Lack of Proper Management practices: The general negligence is common among orange growers, which cause poor yield of trees.

Processing problem: Processing industry in the state can give better price to orange growers.

Strategies

- **Selection of Site**

For establishment of new orchards, sites should be selected at an altitude of 50m – 1500m with annual rainfall ranging from 750mm – 2500mm. Manual cleaning or spraying with Copper-based fungicide is required time to time to control the growth of mosses, lichens *etc*.

- **Planting method**

The state having more than 25-30% slopes, planting should be done along with contour grades on half terraces or bench terraces.

- **Disease Free Planting Material**

Production of disease free planting material should be encouraged.

- **Soil Health Management**

Application of lime advised in regular basis to maintain soil pH. A dose of 600 g N, 200g P2O5 and 200g K2O has been found optimal in bearing orchard of Khasi mandarin to produce 1070 fruits/tree (De. *et al*, 2004). A combined application of 0.1% FeSO4, 0, 4% ZnSO4 and 0.2% CuSO4 as foliar spray is found effective to yield 880 fruits/tree in Khasi mandarin.

- **Irrigation Management**

Microjet irrigation followed by drip irrigation can be helpful to solve water stress problem during dry/winter season.

- **Proper Orchard Management:**

The clean cultivation should be fallow. The tree trunks should be painted by Bordeaux paste upto 1 metre from base. Weeds should be removed from the entire orchard during July-August manually or by the application of glyphosate @ 4 litres/ Ha. Mulching should be done with locally available dry leaves/straw/grasses near the base of trunks to conserve soil moisture during lean period.

- **Management of Insect-Pests and Diseases**
- **Insects - Pests Control Measures**
- Leaf miner Spraying of phosphomidon (1 ml/l).
- Scale insects Spraying of Malathion (0.1%)
- Citrus psylla Spraying with Monocrotophos (0.025%)
- Trunk borer Injecting petrol or nuvan into the holes and by plugging the holes with mud. Spraying with monocrotophos (0.05%)
- **Diseases Control Measures**
- Citrus canker Cutting of infected twigs followed by spraying of 1% Bordeaux mixture.
- Gummosis scraping of the affected area and application of Bordeaux Mixture of copper oxifluoride.
- Tristeza Control of aphids and use of cross protected seedlings.
- Powdery mildew Pruning of dead twigs followed by application of tridemorph or benzimidazole (3 g/l).

CONCLUSIONS

The Arunachal Pradesh is a major centre of diversity for citrus and banana. An average temperature of 8-24°C along with cool summer in the state, favours quality fruit production of mandarin oranges for supply from November to January. Valleys and foot hills are ideal for cultivation for acid limes, Assam lemons, sweet oranges. Amongst rootstocks Citrus latipes, Cleopatra mandarin and Citrus jambhiri have been found as suitable

rootstocks for budding and grafting. Selection of elite planting materials, management of soil health, pruning and traing, high density planting, intercropping, good orchard management practices, Integrated Pest Management and Integrated Disease Management schedules are the key issues which can help to boost the production as well as farmers income.

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