STATUS OF CITRUS DECLINE IN INDIA : A REVIEW

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ABSTRACT

A retrospective overview of work done on the status of citrus decline in India was taken up to study the factors responsible for decline in citrus productivity in different citrus growing belts and the technologies which are available for averting/combatting the menace of decline. The incisive investigation indicated the neglect of orchard, cultivation in unsuitable soil having fertility constraints in terms of available N, Zn, P and Ca, fertility depletion due to exhaustive intercrops, non-availability of disease-free planting material, non-judicious irrigation coupled with poor drainage, infestation of insect pests (Citrus blackfly, psylla, aphid, bark eating caterpillar, trunk borer), infestation of nematode, \textit{Phytophthora} caused foot and root rot, virus and virus like diseases (Tristeza, Psorosis, Crinkly leaf, Infectious variegation and Greening) and bacterial canker are the prominent factors responsible for citrus decline in India. The well proven technologies are available to avert citrus decline provided those are adopted on scientific lines which will help not only to delay the process of decline in productivity but also to rejuvenate the declining orchard and enhance the productive life span of citrus orchards from the present level.

Citrus is the third largest fruit industry in India after mango and banana in respect of area under cultivation. Citrus is grown in 3.8 lakhs ha with a production of 44.3 lakhs tons per annum. The most important commercial cultivars of citrus in India are mandarin (Citrus reticulata Blanco) followed by Sweet orange (Citrus sinensis Osbeck) and acid lime (Citrus aurantifolia Swingle) with a total production of 13.4, 8.9 and 7.5 lakh tons, respectively. Among mandarins, Nagpur mandarin (Central India), Kinnow mandarin (North-west India), Coorg mandarin (Southern India) and Khasi and Darjeeling mandarin (North eastern India) are the major commercial cultivars whereas Mosambi, Sathgudi and Batavian cultivars of Sweet orange are popular in peninsular India. Cultivation of acid lime (Kagi ni morbore) is concentrated in some parts of Punjab, Gujarat, Rajasthan, Nellore district of A.P., Periyakulam of T.N. etc. Among lemons, hill lemon, Italian lemon, Nepali oblong, Baramasi etc. are also being cultivated sporadically. The area and production under citrus cultivation over last 30 years has increased at the rate of 11 and 9%, respectively which shows that expansion of citrus industry was quite sustainable. The average yield of citrus fruits in India is about 7.52 tons/ha which is much lower than citrus yield in other developed countries like U.S.A., Brazil and Japan. The decline or die-back syndrome of the plants in general is responsible for such a low yield.

Citrus decline in India : Citrus decline was first reported in Madhya Pradesh as early as eighteenth century. Later its occurrence was reported in 1912 in Western India (Cheema and Bhat, 1929). The problem of citrus decline in India is quite different from that of decline of in Brazil and Florida Citrus Blight (Nemec, 1988) where the etiology of the problem is not known and no remedial measures are available for these problems. The citrus decline in India is a syndrome of various symptoms and caused by a number of biotic and abiotic factors such as general neglect of orchard coupled with unsuitable site selection, non-availability of disease-free.
planting material, faulty nursery and orchard management practices, nutritional deficiencies, mixed planting, improper spacing, weed problem, unsuitable intercrops, non-efficient use of water, lack of drainage and ignorance about the management of insect pests, nematodes and diseases (Ghosh and Singh, 1993).

The citrus plants after 5-6 years of excellent growth usually start declining with gradual decrease in vigour, yield and exhibit sick look. The magnitude of decline increases with the age of the plant and after 15-20 years, affected plants become uneconomical to maintain.

Factors responsible for citrus decline:

Soil and nutrition: The soil and nutritional problems are amongst major causes of citrus decline, the nature and magnitude of which varies as per agro-climate. The deficiency of Zn, B and Ca were reported by many workers as one of the causes of citrus decline in north east India (Choudhary and Dutta, 1950; Choudhary, 1954; Dutta, 1959 and Ghosh, 1978). The other major factors in the region observed were heavy and long spells (upto 6-7 months) of rainfall, heavy soil erosion due to cultivation upto 60-70% slopes plantation by seedlings, non use of amendments in acidic soils, wide spread zinc deficiency, nutrient cultivation, malnutrition - major and minor elements, absence of control measures for insect pests and diseases and prevalence of tristeza and greening.

The citrus orchards of north-west India were observed suffering due to deficiency of N, Ca, Fe, Mn, Cu and Zn (Dhingra et al., 1965; Singh and Tripathi, 1983, Sharma and Mahajan, 1990; Sekhon et al., 1977; Awasthi et al., 1984) high CaCO₃ (Kanwar and Randhawa, 1960, and Dhingra et al., 1965), inadequate drainage and hardpan formation within 75 cm of rootzone (Kanwer and Randhawa, 1960).

Nilangekar and Patil (1982) observed the poor growth of citrus orchards due to presence of high clay, silt, CaCO₃ in sub-soil, low organic carbon, available nitrogen, phosphorus, low exchangeable Mg, high CaCO₃, salinity and ESP in the surface in citrus orchards of Central India. Srivastava et al. (1997) observed that some mandarin growing soils of Nagpur district having higher clay content mainly concentrated in sub-surface, low coarse fragments sand and CaCO₃ upto 150 cm depth were not suitable for Nagpur mandarin cultivation from regular flowering point of view. The N, P and Zn nutrition of mandarin orchards of Central India (Kothi et al., 1997) and Zn in sweet orange orchards of Marathwada region (Malewar et al., 1977) are not sufficient which may reduce the peak productivity length of citrus orchards.

Other major factors accounting for Nagpur mandarin decline in Central India consist of general neglect, sub optimum soil moisture stress for induction of flowering, scarcity of water for irrigation, lack of drainage due to fine texture of deep black cotton soils, non availability of disease free planting material, wide use of rough lemon as rootstock, no information about nutrient content of orchards, irregular flowering due to high clay content in the sub surface, non-maintenance of proper crop load (Singh, 1997).

Zinc deficiency was found to be one of the main causes for citrus decline in Tamil Nadu (Marudarajan, 1949), Wynaad area (Govinda Iyer and Iyengar, 1956; Mariakulandai and Dorairaj, 1958), Malnad (Aiyappa, 1957) and Mn, Mg, Fe, B and Cu deficiency in Coorg area (Dishit and Bojappa, 1959). The soil factors such as inadequate drainage in citrus orchards in Wynaad district (Nalk, 1949), presence of hard pan rich in CaCO₃ in Kodur district of Andhra Pradesh (Naidu and Rao, 1958) and high soil pH plus excess lime content (Rao, 1948) have
also been reported as contributory factors to citrus decline. The other major factors comprise of more rainfall and humid climate, plantation on seedlings, presence of hard pan, acidic soil pH inducing calcium deficiency, macro and micro nutrients deficiency.

**Insect pests:** Citrus is affected by a large number of insect pests which contribute towards citrus decline (Chadha et al., 1970) Citrus trees in India are attacked by more than 250 insect pests (Bhat, 1979) and about a dozen of them are of economic importance which contribute towards “Citrus Decline” in varying degrees. They are: Citrus psylla, citrus blackfly, whitefly, citrus leaf miner, bark eating, caterpillar, trunk borer, citrus aphid, mealy bugs, citrus thrips, scales and mites infesting all stages of growth right from seedlings in nurseries (Aliappa et al., 1962).

Epidemic of citrus blackfly (Aleurocanthus woglumii Ashby) on Nagpur mandarin during the seventies, eighties and early nineties had put the citrus industry of Central India in doldrums. Widespread growth of black sooty mould (Ceanothus spp.) on the voluminous honeydew secreted by the numerous citrus blackfly nymphs and adults covering the entire tree of orange or lemon, locally known as “Kolish” not only inhibits photosynthetic activity but also affects the appearance and quality of the fruit (Thakre et al., 1985).

**Citrus psylla** one of the important pest of citrus. Citrus psylla (Diaphorina citri Kuwayama) is another serious pest of young flushes that causes heavy flusy drop affecting the fruit set extensively. In severe infestation drying of shoots occurs. It also secretes while crystalline honeydew on which sooty mould grows. More importantly, the insect is an active vector of phytoplasma like organism that causes the dreaded “Greening” disease (Caponi et al., 1967) and thus contributes to the decline of citrus orchards through direct and indirect spread of greening (Ghosh, 1985).

Two major species of citrus aphid attacking citrus are brown citrus aphid (Toxoptera citricidus Kirkaldy) and black citrus aphid (T. auranti). The real importance of aphids is due to their relation with the tristeza virus. Brown citrus aphid is the efficient vector of tristeza that is “quick decline” which played havoc with the citrus industry of Argentina, Brazil and California and has been reported to be present in Maharashtra (Nagpal, 1959), Andhra Pradesh (Reddy and Paparao, 1960), Delhi (Narayan et al., 1965) and also in Punjab (Anon. 1965).

Two species of bark eating caterpillar (Inderbala quadrinotata Wealeco and T. tetraonis Moore) which are quite serious in neglected orchards. Of late, the infestation is spreading even in the young orchards of Nagpur mandarin alarmingly. Twigs and branches get partly grided such, branches tend to flower and fruit profusely more than normal and break or decline fast without carrying the crop to and break or decline fast without carry 60% orchard crop to maturity (Rajput and Haribabu, 1999). As high as 40-60% orchards suffer from this pest in Vidarbha (Thakre et al., 1984, Shivanker, 1997). The yield and fruit quality are affected (Bindra, 1969). A single borer can kill one tree.

**Citrus trunk borer** (Monochamus versicolor Nitzsma) is a serious insect pest of mandarin orange in North Eastern region and Sikkim. In Assam 15 to 60% orchards are under the spell of this pest (Chaudhary, 1954 and Sachan, 1981). It is equally serious and responsible for citrus decline in West Bengal (Nayer et al., 1976) whereas, about 20% mortality of mandarin plantations has been reported from Assam (Dutta, 1959).

**Diseases:** Almost all the citrus tracts face the problem of Phytophthora spp. causing...
varying degree of root rot, crown rot, gummosis and brown rot of citrus in India (Bajwa 1941; Chowdhury, 1951, Lele and Kapoor, 1982; Naqvi, 1988 and Somani and Patel, 1972). Besides *P. parasitica* and *P. citrophthora* (Naqvi, 1988), *P. palmivora* (Lele and Kapoor, 1982), *P. arecae*, *P. nicotinae* are also reported to cause enormous damage to citrus plantations.

Predisposing conditions for *Phytophthora* diseases like poor drainage, excessive irrigation, water logging, prolonged contact of water with tree trunk and use of susceptible rootstocks should be avoided (Naqvi, 1988).

**Management of Citrus decline**: The research work carried out on citrus decline in India during last 5-6 decades directly or indirectly to solve this problem in order to improve the citrus industry by targeting higher productivity.

**Supply of disease free quality planting material**: Disease free nursery stock is the pre-requisite for establishing a viable and productive citrus industry. Two to three million plants of Nagpur mandarin are being multiplied every year in about 250 nurseries located in Amravati and Nagpur districts of Maharashtra and are being supplied to all over country without any certification for purity and disease. Hence, many of the diseases are spreading like fire to virgin areas due to sheer ignorance of multiplication from certified budwood. There is an urgent need to check this spread and to develop virus free reserve source of budwood for future multiplication. Strict quarantine and budwood certification programme must be started on the exact lines of Citrus Variety Improvement Programme of USA, Spain, Brazil, etc. at district level to supply the healthy plant material to growers. Use of 'Nursery act' to enforce sanitation and supply of disease free plants is a must for citrus which suffers from a number of transmissible diseases. The shoot tip grafting technique has already been standardised by NRC for Citrus and BCKV, Kalyani to eliminate the virus and virus like diseases from elite germplasm of citrus. Development of mother blocks with virus free material will go a long way in production of quality planting material in citrus.

**Proper orchard management**: Majority of citrus orchards in different states are found deficient in NPK and other micronutrients. Excessive harvest and inadequate fertilization in addition to erratic irrigation schedules coupled with non- judicious inter-cropping result in early decline of vigour and productivity of citrus plants. The suitable inter crops such as Cotton in Kinnow growing areas of Punjab (Singh and Bakhshi, 1961), Soyabean and vegetable crops like peas, turnips, cabbage and kohlrabi for rabi season and bottle gourd, bitter gourd, lady's finger during kharif season (Katyali and Chadha, 1960) have shown great promise as intercrops in various citrus growing areas.

Chemical weed control is equally important in commercial citrus cultivation. Application of Diuron as pre-emergence herbicide at the rate of 3 kg a.i./ha in black clay soil was observed to control weeds upto 300 days in a year when second spray was given at 120 days after the first.

**Role of rootstocks**: The rootstocks have most prominent effect on growth, productivity, fruit quality and longevity of the tree on one hand and influence the susceptibility of the trees to various insects and diseases on the other hand (Chadha et al.1970). The studies on influence of different rootstocks on the incidence of the dieback disease, rootstocks trials with about 32 different rootstocks are in progress and some of the rootstocks such as Rough lemon (*Citrus jambhiri* Lushington), Belladakithuli (*Citrus maderaspatana* Tanaka) and Baduvapalli (*Citrus
The citrus decline is caused due to rootstock scion incompatibility which may be either viral or genetic. The presence of some virus infection in the Malnad area of Mysore state. Recently, greening disease is also suspected for causing decline (Fraser, 1967). Nauryal and Choudhary (1968) also reported the presence of virus in a number of sweet orange trees examined by them and they suspect these symptoms to be caused by a virus. In India most of the citrus plantations is established using rough lemon rootstock which is not only susceptible to salinity and root and foot rot but also vulnerable to nematode infestation which could be major reasons for citrus decline. But despite so many rootstock trials no rootstock trial could provide a permanent alternative to rough lemon rootstock which could have better resistance.

Use of growth regulators: Not much work has been done with reference to use of growth regulators for limiting the crop load. A reasonable amount of thinning using NAA and ethephon has been noticed (Asli and Ali, 1970). Application of NAA (350 ppm) 35 days after full bloom induced reasonable amount of thinning followed by hand thinning and ethephon (200 ppm) and regulated the crop in the subsequent year. Application of 2,4-D (10 ppm), pyracetol (100 ppm), and 2,4,5-T (20 ppm) were not of any practical significance to induce thinning and regulate crop production of Kinnon (Sharma and Awaasith, 1990).

Soil management: Citrus is sensitive to soil factors such as high pH, presence of excessive salts in the root zone, inefficient drainage, presence of hard pan in subsoil, free lime, deteriorated soil structure (Kanwar and Randhawa, 1960) and an integrated effect of these soil factors lead to chlorosis induced decline in productivity (Dhingra et al., 1966).

In Kinnon growing areas, where the soil pH is beyond 8.5 either regular application of gypsum or heavy use of organic manure or both is used as soil amendment on regular basis. The presence of hard pan in subsoil of Kinnon growing soils is a common phenomenon. In such soils provision of drainage has to be kept mandatory.

Nutrient management: The N, P, K requirement of different citrus species were observed as 400: 200: 200-400 g/tree for Kinnon mandarin, 300: 250: 300 g/tree for khasi mandarin, 600-800: 200: 100-400 g/tree for Nagpur mandarin, 400: 200: 200 for acid lime grown in Periyakulam (Anon., 1991). Srivastava and Singh (1998) recommended 600 g N, 200 g P.O., and 100 g K.O as optimum fertilizer dose of Nagpur mandarin in Central India. Zirc deficiency can be corrected with 1-3 sprays of neutralised 1% zinc sulphate which lasted for 3-4 years. Kanwar and Dhingra (1962) observed reduction in chlorosis with spray of 0.6% zinc sulphate in two years (Dhali and Bhamboota, 1967). The foliar spray of zinc sulphate along with borax and urea has also shown promising results in reducing the chlorosis (Sharma et al., 1974). The chelated zinc has also shown good results in which zinc-humic acid (Khanna et al., 1969) and zinc sequestrine (Aiyappa and Subramaniam, 1959). Ahmed (1960) recommended foliar spray of Fe-EDTA in calcareous soils showed good results for removing the decline in productivity due to iron chlorosis.

Efficient use of water: Flood irrigation is the usual method of irrigation in most of the citrus growing areas excluding the north east and Coorg, incurs lot of wastage of water.
Fertilization technique of applying nutrients and water simultaneously holds a big promise in citrus orchards (Koo, 1984).

The preliminary studies on the effect of soil management system on soil moisture in sweet orange orchard was initiated by Randjewa (1960) who emphasized the irrigation aspects of Citriculture in India (1986). Mageed (1988) carried the research of influence of irrigation and nitrogen on water use and growth levels of nitrogen (0, 115 and 230 kg N/tree) the consumptive use varied from 66.7 to 132.5 cm. The water requirement of Nagpur mandarin was determined as 651.0, 849.0 and 997.3 mm/year for young, middle age and mature trees, respectively using the predicted potential evapotranspiration based on meteorological data (Ghadakar et al., 1989). Water requirement of 1 to 3 and 5 to 8 year old Nagpur mandarin over 9 month (Oct.-June) was observed to increase according to age and canopy size (Authar et al. (1989). Makhija et al., 1986) observed water need for 6 year old Kinniow mandarin varying from 539 to 1276 mm depending upon the level of irrigation with average consumptive use of water in 2 years as 615 mm.

Ray (1990) observed that the water use increased as per frequency of irrigation increased. The highest bio-mass per plant was obtained with irrigation was scheduled at -0.05 Mpa SWP and 18-19 irrigations were obtained. The best tree growth in terms of truck diameter, plant height, canopy volume, leaf number and shoot growth was also obtained at -0.05 Mpa SWP using 182.4 cm water/tree/annum.

Disease management:

Fungal diseases: Spray and drench of Metalaxyl or Fosetyl a1 provides effective control of Phytophthora diseases (Naqui and Savant, 1994). Use of Trichoderma culture also controls Phytophthora at the disease development stage (Savant et al., 1995). Twig blight can be controlled by pruning the dead twigs followed by two monthly sprays of carbendazim (0.5%) (Naqui, 1993). Powdery mildew can effectively be controlled by spray application of triadimefon, dinocone and benzimidazole fungicides at 10 days interval after first sign of attack (Narasimhan et al., 1984).

Virus and virus like diseases: More than 15 virus diseases of citrus have been reported from India. Among them tristeza, psorosis, crinkly leaf, infectious variegation and greening are wide spread (Raychaudhary and Alhawat, 1984; Reddy and Rao, 1960). Xyloporosis impetigiosa, leathery leaf, woody gall, tumour, multiple sprouting, rubbery wood etc. are limited to certain parts only (Alhawat and Raychaudhari, 1988). Planting of virus free planting material is the basic need of the industry virus elimination. It may be achieved either through shoot tip grafting or by nucellar plants (Kapur and Sohi, 1988; Dhillion et al., 1983). Budwood thermotherapy also eliminates the viruses (Raychaudhari, 1972). Citrus aphid (Toxooptera citricidus Krik) the vector for tristeza and citrus psylla vector for greening should be controlled to check the spread of these viruses (Randhawa and Sriastava, 1986).

In India, CTV cross protection was initiated in early 1970’s. Based on lime reaction alone Babaraman and Ramakrishnan (1980) selected mild CTV strain and used them for cross protection, demonstration trial at several locations of Bangalore, Tirupati and Periyakulam. Though initial 5 to 6 years it was giving promising results in terms of growth of acid lime plants after wards it failed, and no significant yield differences were recorded. Recently mild strain cross protection for CTV has been initiated at NRC for Citrus, Nagpur and IIHR,
Bangalore. Similarly, CTV cross-protection is successful in Australia (Broadbent et al., 1991), Japan, Florida (Lee et al., 1987), Spain etc. (Kolzumi et al., 1991).

**Bacterial disease:** Mandarins were supposed to be tolerant to citrus cankew but now certain strains are observed pathogenic on Kinnow plantation at Akola (Maharashtra). Pruning of infected twigs before monsoon and spray of 1% Bordeaux mixture was found effective. Streptomycin in combination with Bordeaux mixture or CCOC also give effective control (Kale et al., 1994). Improved selected clones of citron like Saisarbari and Premalini are tolerant to canker.

**Management of nematodes:** Citrus nematode, Tylenchulus semipenetrans is the most widely distributed nematode in all the citrus growing areas (Reddy and Singh, 1979). Dichlorofenuron @ 45 l/ha was found to reduce nematode population by 80% (Mukhopadhyay, 1970). Ethoprophos @ 40 kg, a.i./ha also reduced 97.6% in sweet lime and increased the yield by 39.9% (Mukhopadhyay and Dalal, 1971). Another study revealed that fenitrothion @ 30 kg a.i./ha was highly effective on pummelo with 68-76% increase in yield (Chhabra et al., 1978).

**Management of Insect Pests:** First and second nymphal instars of the pest are more vulnerable to control measures hence the spray schedule should be undertaken at 50% egg hatching stage that ensures maximum coverage of the younger stages of the pest in two sprays to be effected at 15 days interval with either monocrotophos 1 ml, acephate 0.8 ml, phosphamidon 0.7 ml, phosalone 1.5 ml or dimethoate @ 2 ml/l of water till drenching that ensures thorough coverage of the underside of leaves (Anonymous, 1994).

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<th>Time of control</th>
<th>Period of 50% egg hatching</th>
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<td>l. Ambha</td>
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Use of predators like Mallocia boninensis and Serangium mormocanum and a parasitoids Encarsia sp. and Eretmocerus gunturensis hold a promise in the control of the pest biologically. The pest activity is maximum during June-July, Sep-Oct., and Mar-Apr and the spray at such time with 0.3 ml phosphamidon or quinalphos 1 ml or thionetan 1 ml/l of water gives effective control of the pest. The host specific aphid parasitoid Taxaria radiata holds promise for the control of the pest because as high as 40-50% and even above 90% parasitism was recorded at certain locations in Vidarbha (Shivankar, 1996).

The Inderella can be controlled effectively with 1-2 sprays of systemic contact insecticides available. Two natural enemies of the pest namely Syrphus spp. and Coccinella Septempunctata were found predating upon the pest. Of these Syrphus sp. was predominant (12.72% in relation to aphid population) throughout the pest incidence. Growth of pests Inderella can be controlled by injecting petrol, carbon disulphide or nujan into the holes and by plugging the holes with mud. Removal of frass and spraying with monocrotophos 0.05% is an effective control measure. The best time for control is Sep-Oct and Jan-Feb. The alternate hosts in the vicinity like jamun, guava, litchi, pomegranate, jujube may also be treated in case of severe infestation (Bindra, 1970).

Chemical control of aphid as a vector is the most acceptable approach to greening control. Insecticides like azodrin 40 (monocrotophos), dimethoate, aldicarb, quinalphos, fenvalerate, fenction, phosalone, fenitrothion and endosulfan were used against psylla and were found quite...
effective (Khanna and Mathur, 1978 and Tandon 1992). Extracts/oils of seed kernels of Azadirachta indica, Pongamia glabra Madhuca longiflora, Ricinus communis, Cymbopogon nardus leaves Alpinia galanga bulbs and several others alone or in combination have been tried successfully against citrus insect pests (Borle 1974, Pande, 1982, Anonymous, 1989, Chin et al., 1990, Katole 1974, Pande, 1982 and Tandon and Johri, 1993, Savitri et al., 1997). However, exhaustive studies on this aspect are required to be undertaken.

In India (Punjab) Cocinella septempunctata L.C. repanda Thunb. Mnemonius saximaculata Fab. Chilocorus nigritus (F.), Brumus suluralis F. Chrysopa sp. Syrphids have been reported predaing on psylla (Singh, 1993 and Tandon 1993). Among the parasitoids the eulophid Tetrastichus radiatus Watson has been found effective in regulating (Narayananan) and Diaphorocyrtus aligharenisis have been reported from Vidarbha (Tandon, 1993). As high as 95% parasitism of citrus psylla by T. radiatus has been reported (Singh, 1993).

Citrus leaf miner Phyllocnistis citrella although basically the seedling pest at times invades the orchards in new flush epidemically causing enormous loss to the vegetative growth of the plant. More than 80% nurseries are infested by the pest in Central India (Kalidas and Shivanakar, 1995). Vidarbha (Ghuguskar et al., 1991) in 1981 summer during which more than 87% leaf damage was recorded and also more recently in the Ambia flush of 1998. In India, a rich fauna of bioagents of the pest is found which can prove to be the greatest asset in controlling the pest menace. Parasitoids, like Tetrastichus phylocnistodes, Cirrospilus quadristriatus, Elasmus claripennis, Bracon phylocnistoides and Simulipes purpurea have been recorded causing 30-45% parasitism. Black chalcid larvae Ageniaspis spp. was found causing 80% parasitism of the moth (Anonymous, 1991).

Fruit sucking moth, Others spp. is the regular and serious pest of ripening citrus fruits causing 25-40% fruit drop, particularly during Sept.-Oct. (Shivankar and Kohli, 1996). Citrus mite Eutetranychus orientalis is another pest which not only damage the leaves but also the fruits causing the unpleasant blemishes on the peel, deteriorating the quality. Some predatory mites have also been recorded (Shivankar and Kohli, 1996). Lemon butterfly, Papilio demoleus feeds voraciously on the vegetative growth throughout the year. The outbreaks of the pest were reported in 1940, 1969, 1982 and 1983 and more recently in July, August 1996 from Vidarbha (Thakre et al., 1984-85 and Shivankar and Kohli 1996). Bark eating caterpillar Inderbela quadrinotata which was a minor pest a few years ago has now assumed the serious dimensions by infesting around 40-65% both old and young orchards necessitating an immediate attention of the growers and also the scientists. Pest incidence has been invariably notices in the declining orchards in central India. The larval parasitization by Apanteles spp. was recorded in case of both lemon butterfly and bark eating caterpillar (Shivankar and Shyam Singh, 1997).

Future line of work: In view of the seriousness of the problem being faced by the citrus industry due consideration should be given to tackle citrus decline in totality and on priority.

1. Delineation/identification of the factors responsible for citrus decline and their remedies will have to be taken up.

2. Budwood certification programme is must. A cross protection strategy need to be worked out in order to make the disease free planting material available.

3. Integrated nutrient and water management studies: Development of ‘leaf’ nutrient indices
as ready reckoner to diagnose the fertilizer requirement and scheduling and development of fertigation techniques accordingly.

4. The mother plants should be selected from the declined orchards which will help in transfer of existing resistance in new planting material to be raised for future.

5. Breeding of rootstocks and scions for resistance/tolerance to salinity/drought and to Phytophthora/nematodes etc. for the variety having desirable horticultural and processing characteristics.

6. Water management technology: Water table particularly in Central India is going down. Management of available water is equally important which can be achieved through micro and drip irrigation techniques which need to be refined.

7. The quantum of stress as per soil type requires to be standardised in the areas where soil water deficit stress is adopted for induction of flowering.

8. Alternatives to soil water deficit stress used for induction of flowering in Nagpur mandarin needs to be found out which otherwise accelerates the pace of decline.

9. An optimum crop load must be standardised avoiding "off" and "on" year to avert the citrus decline.

10. Development of integrated pest, nematode and disease management strategies approaches including the use of natural enemies of insect pests and antagonistic organisms against Phytophthora virus, Bacteria, Canker and nematodes etc.

11. Forecasting models for the outbreaks of insect pests and pathogens to enable us to take prophylactic measures should form the important agenda.

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