World Citrus Problems - V. Nepal

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In Nepal, citrus is grown commercially at altitudes ranging from 600 to 2,450 metres and between latitudes 26.5° and 28.5° north. Citricultural problems are largely due to the occurrence of disease and to difficulties in transporting the produce derived from 8,000 hectares of citrus trees. With but few roads, the crops are borne mainly on the backs of bearers, along paths about 60 centimetres wide, over interminable mountains, across fords, and five or six days later to the marketplace. Citrus is grown extensively only in the few localities where there are roads.

Areas such as Pokhara have long exported surpluses to India, but within recent years production has fallen off sharply. A decade ago, trees began to decline which earlier had flourished for 40 years, and today production of citrus fruit cannot even meet local requirements.

At the request of the Government, and with the financial assistance of the United States Agency for International Development and the Government of Nepal, the senior author visited the citrus-growing areas of the country on two occasions (5-13 March and 4-15 September 1969). Areas visited by both authors were Pokhara and Gorkha in west Nepal, Kathmandu in central Nepal, and Dharam, Dhankuta, Khoku, Patle, Bhojpur, Dingla, Ilam, Sunbuk, Panichthner and Ilamgau in east Nepal (Figure 1). Due to the nature of the terrain, much of the survey had to be undertaken by helicopter, and landings effected wherever patches of citrus were observed.

The overall objective was to account for the recent decline affecting citrus plantings, but opportunity was also taken to note other diseases and pests of citrus in the area. The present report records previous findings, as well as information from the files of the Nepalese Department of Agricultural Education and Research and the Ministry of Food and Agriculture.

Disease problems

GREENING VIRUS DISEASE

In 1967, Thrower (11) mentioned the recent decline of citrus and cited grower observations that symptoms first appeared about 1964. Later, Catling (1) visited the area around Pokhara and, on symptomatological grounds, considered the decline to be due to greening virus. He also noted the presence of Diaphorina citri Kuw., the Asian vector of the virus.

To confirm previous diagnoses based on symptoms, twig samples were collected and assayed according to the Schwarz chromatographic technique (10), which correlates in-

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Figure 1. Sketch map of Nepal and routes of the survey of citrus production problems (5-13 March and 4-15 September 1969).

Infection with markedly increased levels of gentisoyl glucose in the bark of infected trees (3). In collecting samples for the test, specimens of two-year-old twigs were cut from four sides of each tree and preserved and extracted in 75 percent ethanol. After evaporating the extractant under vacuum, the residue was redissolved in ethanol and spotted on Whatman No. 1 chromatographic paper, using a water-saturated solution of n-butanol as carrier. Papers were then examined under an ultraviolet lamp (Hanovia Model IV, emitting 95 percent radiation at 366 nm) for presence of the fluorescing gentisoyl glucose marker substance.

A total of 132 trees were sampled from Pokhara to Ranigaum, ranging from 0.7 to 50 years of age. Top condition varied from severely declined to apparently normal, and seedlings as well as budded trees were included in the survey.

A summary of findings is given below; a more detailed account is presented by Knorr et al. (7).

1. For the country as a whole, 54 percent of the trees sampled gave chromatograms indicative of infection by greening virus. The incidence parallels that found in the Indian Indo-Gangetic Plain where, out of 626 trees sampled, 69 percent were positive according to the Schwarz test (4).

2. There was little difference in incidence in the three regions. In west Nepal, the in-
Infection rate was 53 percent, in the Kathmandu valley 43 percent, and in east Nepal 59 percent.

3. There were some positive results in all varieties sampled. Among the major varieties, the distribution of supposedly infected trees was: sweet oranges, 71 percent (5/7); mandarins, 51 percent (51/100); and mandarin hybrids (Kinnow and Fewtrell’s Early), 67 percent (12/18).

4. Modes of virus transmission are reflected in the results obtained with two groups of trees, one budded and the other seedling. Most trees on rootstocks are imported from Saharanpur, Uttar Pradesh, India, an area in which previous chromatographic determinations (4) indicated that 54 percent of 26 sampled trees were infected. In west Nepal, it is customary to plant budded trees and in east Nepal seeds. Seedlings are presumed to be free of virus at the time of germination, yet out of 80 seedlings sampled throughout the country, the Schwarz test indicated that 54 percent had become infected. The incidence of spread by vectors, as determined chromatographically from bark samples of seedling trees, is approximately the same throughout the country: in west Nepal it was 48 percent (15/31), and in east Nepal 59 percent (26/44). There was little correlation between age of seedlings and the presence of the marker substance. Seedlings in the five age groups, i.e., 9 months, 1-5 years, 6-15 years, 16-25 years and 26-35 years, suggested that the rate of transmission was approximately the same in all groups. This tends to support grower reports that infection and spread have occurred within the last decade.

5. There was poor correlation between tree symptoms and chromatographic results. Lack of correspondence suggests the possibilities that at times symptoms are masked due to varietal, nutritional and seasonal factors, that they are obscured by diseases other than greening, that in recently infected trees they are not yet apparent, and that sampling procedures, though involving four positions per tree, are inadequate for detecting the presence of the marker substance in each case.

Some relief from the depredations of greening disease may come from the planting of Fewtrell’s Early, a tangor often found infected but which appears to tolerate greening infection much better than other varieties growing nearby (Figure 2). Although 70 percent of the trees of Fewtrell’s Early at Malepatan fruit experiment station, Pokhara, contained the marker substance, indicative of infection by the greening pathogen, the absence of chlorosis and dieback was conspicuous.

OTHER VIRUS DISEASES

There was not enough time to index trees in order to determine the various virus diseases present, but where there were recognizable symptoms the trees were recorded. Since seedlings are grown throughout the country, except at Malepatan, it is evident that none of the recent decline is attributable to bud union related viruses, such as tristeza, xylporosis or exocortis.

Tristeza. On the basis of vein clearing symptoms, this disease was found in a single, stunted kaghzi lime tree at Pokhara. The efficient
vector *Toxoptera citricida* (Kirk.) is known to be widespread in Nepal, but losses from tristeza are undoubtedly minimal because most rootstocks in use are tolerant and seedling culture is practised in most orchards.

*XYLOPOROSIS.* Three instances of xyloporosis pitting were seen in scions of budded Nagpur mandarin trees 11 years old. This virus disease would not be expected to be serious in a country where seedling culture of tolerant varieties is general and where, when budded trees are occasionally grown, the tolerant karna khatta is used as a rootstock.

*Bud union crease.* Of six 11-year-old Blood Red sweet orange trees on *Citrus jamhiri,* three showed eruptive bud union crease. The same disease is prevalent in the Indian Punjab, but the low incidence at Pokhara is probably attributable to the predominant use of the tolerant karna khatta stock.

**FUNGAL, ALGAL AND BACTERIAL DISEASES**

*Powdery mildew,* caused by *Oidium tingitanum* Carter,\(^4\) is common throughout the country. In east Nepal, the disease at times assumes economic importance.

*Anthracnose,* incited by *Alternaria citri* Ellis & Pierce \(^5\) and often accompanied by *Colletotrichum gloeosporioides* Penz.,\(^4\) is encountered frequently in the foliage of certain varieties at Pokhara; however, damage is negligible.

*Greasy spot,* caused by *Mycosphaerella* sp.,\(^5\) is common in the foliage of trees in west Nepal and in the Kathmandu valley.

*Pink disease,* caused by *Corticium salmonicolor* Berk & Br., is troublesome throughout the country during and following the monsoon season. At the Malepatan fruit experiment station, Pokhara, infected limbs are pruned out continually, further reducing the stature of trees.

*Pinpoint blast,* the cause of which is undetermined, is a name applied to a rather serious infection of newly expanding leaves and blossoms. It affects many varieties at the Malepatan station, and is tentatively considered as a fungal disease. The blast was not seen in March but was much in evidence toward the end of the monsoon season. Varieties particularly affected were Kinnow, Fewtrell’s Early, Blood Red sweet orange, and the Nagpur, Pokhara and Srinagar types of mandarins. The varieties Nagami kumquat, Eureka and seedless lemons and kaghzi lime were not affected.

*Bacterial canker,* caused by *Xanthomonas citri* (Hasse) Dowson, was found in many trees of the variety collection at Malepatan. Kaghzi lime (similar or identical to West Indian lime) and Eureka lemon were most severely infected. Other varieties attacked were Kinnow and the sweet orange varieties Musambi, Malta Common and Blood Red. In east Nepal, canker was seen only in shaddock. Infections were not found in trees of Fewtrell’s Early tangor, Nagami kumquat and the Nagpur, Srinagar and Pokhara selections of mandarin. Since varieties most commonly grown in Nepal are mandarins, the disease is of minor economic importance.

Miscellaneous declines were found affecting trees that failed to register chromatographically the presence of greening virus disease. Allowing for reasons described under “greening” to account for lack of consistency between tree condition and chromatographic results, it is nonetheless apparent that factors other than greening are involved in Nepal’s citrus decline problem.

Miscellaneous pathogens reported earlier are added here to complete the record. The following microorganisms on citrus described by others and confirmed by the Commonwealth Mycological Institute, London, are: *Cephalcius virescens* Kunze, *Elsinoe fawcettii* Bítane & Jenkins, *Glomerella cingulata* (Stonem.) Spauld. & Schenk, *Phomopsis citri* Fawc., & *Tricharia* sp. (5). Records of the Commonwealth Mycological Institute, Kew, London, contain additional determinations: *Calonectria diploa* (Berk. & Curt.) Wollenw., *Coniothyrium fuckelii* Sacc., *Nectria flamma* (Tul.) Dingley, *Phyllosticta* sp. and *Septoria* sp.

\(^{4}\) Khadka and Moin Shah, 1967 (5).

\(^{5}\) Khadka and Moin Shah, 1969 (6).
Entomological problems

Of the many known pests in Nepal that are destructive to citrus elsewhere in the world, none constitutes a serious problem at present. Oriental citrus psyllid (Diarhorina citri Kuw.), the vector of greening virus in Asia, had been reported previously from Nepal (8).

Aphids were not plentiful during the March and September surveys. Small numbers of Toxoptera citricida (Kirk.), the efficient vector of tristeza virus, were observed. An earlier report (8) mentions the occurrence of T. aurantium (Fonsc.), also a vector of tristeza but a relatively inefficient one.

Scales of various species were seen but infestations were low. California red scale, Aonidiella auranti (Maskell), was encountered on Citrus limon Burm. at Pokhara, and Saissetia oleae (Walker) on C. reticulata at Sumbek. Previously reported findings on citrus include Aonidiella orientalis (Newstead), Aspidiotus destructor Signoret, Coccus hesperidum L., Fiorinia theca Green, Hemaspisoplocus ciferrei (Green), Hemiobesia rapax (Comstock), and Lepidosaphes beckii (Newman) (8, 9). Records of the Commonwealth Institute of Entomology, London, mention also the presence of Pulvinaria psidii Maskell.

Mealybugs were encountered only at Pokhara, the species being Pseudococcus citriclus Green. Mentioned in previous reports (8, 9) are Icerya seychellarum (Westwood), Nipaecoccus vastator (Maskell), and Green’s mealybug, mentioned above.

Whiteflies of several undetermined species were seen in abundance at Kathmandu. Reported earlier (9) was Bemisia giffordi (Kotinsky).

Blackflies were not encountered during the survey, but Aleurocanthus sp. had been reported earlier (8). According to the Commonwealth Institute of Entomology, the species is now known to be A. vogrini Ashby.

Hemipterous insects, as recorded at the Commonwealth Institute of Entomology, include Dalpada sp., Dysdercus evansensis Dist., Oxyrhachis sp., and Otinotus oneratus Walk. Another source (8) mentions the presence of Rhynchocoris humeralis (Thunberg).

Coleopterous species recorded at the Commonwealth Institute of Entomology include Jauravia quadrenota Kapur, Agoniaschius sp., Xanthopenesth sp., Agrius sp., Glycyphana horsfieldi Hope, Oxyetonia jucunda Fald., Thaumastopus pulvis Bibb., Colasposoma semicostatum Jac. and Castida sp.

Lepidopterous species, reported earlier (7), include Papfla demoleus L., P. macraon L., and P. polytes L. In addition, the Commonwealth Institute of Entomology records Argina cibaria Cl. and Euprostis xanthorrhoss Koll. Serpentine leaf miner, Phyllolcistis citrella Stanton, was much in evidence at Pokhara. While all varieties of citrus showed leaf tunnelling, the amount was moderate in comparison with attacks seen in some parts of India and on the Arabian subcontinent.

Oriental fruitfly, Dacus dorsalis Hendel, has not been recorded in the literature from Nepal. However, it was learned from P.N. Rana, entomologist at the Nepalese Ministry of Agriculture, that this species has recently been found in the country’s citrus orchards, and is said to be rather serious in the Inner Tarai on mandarin fruits.

Citrus rust mite. Phyllocoptruta oleivora (Ashm.) was found in large numbers in the Pokhara area and was the cause of fruit russetting in many varieties.

Spider mites. Eutetranychus sexmaculatus (Riley) was not encountered but was reported earlier as a minor pest of citrus (9). Eutetranychus orientalis (Klein) was found during the March survey on Citrus jamhiri Lush. at Pokhara.

False spider mites. Brevipalpus californicus (Banks) was encountered on mandarins at
Pokhara and Sunbeks. This is the species that produces leprosis on citrus in Florida, but no symptoms of this disease were seen in Nepal. In mandarins, B. californicus does not cause leprosis, even in mixed plantings in Florida, where the disease is destructive to sour orange and erity and mid season varieties of sweet orange. The species was also found on the Malabar nut (Adhatoda vasica Nees) at Pokhara. B. obovatus Donn., the cause of leprosis in South America, was found on shaddock at Patan but symptoms were not present.

From a comparison of the distribution of these pests with that given by Ebeling (2), it will be seen that most of the insects and mites described above have been reported from India. It is likely that some were brought into Nepal with nursery stock.

Conclusions and summary

Much of the recent and sudden decline of citrus trees in Nepal was found to be associated with the marker substance indicative of the presence of greening virus. According to growers, trees thrived until about 1964, when, dieback, leaf chlorosis and fruit drop became conspicuous.

The incidence of greening disease, as determined by the Schwarz chromatographic test, was found to be 54 percent among 132 trees sampled in the area from Pokhara to Ranigaun. Field spread by the vector Diaphorina citri appears to have taken place at a uniform rate throughout the country, on the basis of the presence of the marker substance in seedling trees. The virus may have been introduced through recent importations of budded trees from Saharanpur, Uttar Pradesh, India, an area where previous chromatographic determinations suggested that 14 (54 percent) out of 26 trees sampled were infected. No records have been found indicating the presence of D. citri in Nepal before the advent of greening decline.

Among other insects and pests encountered, the following appear to be first records for the country: Brevipalpus californicus (Banks), B. obovatus Donn., Phyllocoputra oleivora (Ashm.), Eutetranychus orientalis (Klein), Aonidiella aurantii (Mask.) and Saissetia coffeae (Walker). An unpublished record indicates the presence of the oriental fruitfly, Dacus dorsalis Hendel.

The inaccessibility of most citrus plantations militates against a concerted attack on diseases and pests with chemical protectants, and the innumerable mountain approaches to the country preclude effective enforcement of plant quarantine measures. The only means of saving the citrus industry of Nepal would appear to be the use of resistant varieties. The tangor Fewtrel's Early shows promise of tolerating the virus of greening disease.

Literature cited

