

IS THE CLIMATE OF SINDH SUITABLE FOR RAISING CITRUS FRUITS?

**By
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The wiping out the 150,000 acres of banana by BBTV (Banana Bunchy Top Virus) and HR (Heart Rot) in 1989-91 and removal of roses from 100,000 acre in Sindh due to collapse of export market in 1989, had created an urgent need for introduction of replacement crops. The farmer wants to know, what are the new crops, their economics, agronomical requirements, diseases, pests, markets and pay off periods? Since no one in the country expected the urgency, replacement crops were neither studied nor planned. The answer therefore was as confusing as the problem of replacement.

We had been doing these studies since 1981. The prices of mango had started coming down, since that year and in the terms of real value, the mango prices of 1990 were about 40% of 1981 prices and in 1998 about 20%. Banana was doing better than mango, as prices in 1990 were about 50% of 1979 prices recovery may not come, due to glut created by vast area under Sindhri mango plantations in Sindh. We studied citrus and many other alternative crops in details and raised them on a small scale to understand their agronomy and economics. Sindh had developed considerable citrus industry with the opening of Sukkur Barrage in 1932, but it had suddenly collapsed in late fifties. The causes of this failure had never been studied and a hasty conclusion was drawn that Sindh's climate is not suitable for citrus. It was period of "One Unit" during which there was strong prejudice against Sindh's being highly competitive with the Punjab and our horticulturist collaborated towards doom of this industry. Thus citrus was out once for all. We have studied these causes and found that they had nothing to do with the weather of Sindh. It was triteza virus and zinc deficiency. Besides there was lack of knowledge about plant protection and non availability of suitable chemicals and spray equipments.

Agro climatology is no longer given due importance as the British had given to it, before Independence, upto 1947. Mukhtiarkars of every Taluka, was reporting telegraphically the daily data about maximum and minimum temperatures and rainfall to the Meteorological Department as well as to the Director Agriculture in Sindh. The latter compiled them month-wise and published in the Sindh Government Gazette once a year along with average since 1904. The last such data for 41 years (1904-1945) were published in 1946. Then we got independent of this drudgery, the Indian Meteorological Department also published annual climatic data and also separate rain fall volumes. These go back to year 1891 and 1897 and cover some 11 station of Sindh. Since 1904, data was available for all 65 Talukas of Sindh. the daily maximum and minimum temperatures and rainfall for Karachi, Hyderabad, Pad-Idan, Rohri and Jacobabad along with major Indian cities, were published by all English and Sindhi news papers. These formed a basis of understanding agro-climatology.

Another source of data is offices of Executive Engineers Department of Irrigation. In the recent years WAPDA collect and compiles data. Pakistan Meteorological Department has 22,000 employees. Data has been collected but has not compiled to give annual, monthly and daily averages for past years. All Agricultural Research Farms in Sindh also collected daily climatic data, but they are not compelled. We started collecting data from various agencies and have prepared monthly summaries for some 18 stations. In addition to these we have also worked out Heat Indices and Chill Units for all these 18 places. The results are astonishing, the accumulated Chill Units [C.U] (hours below 7.2°C) for Sindh are the highest in Larkana (550 C.U). the coldest belt of Sindh is Larkana, northern Dadu and western parts of Naushero and Khairpur districts. After Ghorabari and Karachi, the Hyderabad town is the least cold (150 Chill Units) in winter. Tando Jam accumulates twice as much chill as Hyderabad, only 11 miles from the former.

In terms of heat accumulated or Heat Index (temperatures over 13.0°C in summer months), Jacobabad, is warmest (4469 Heat Index), and Mirpur Sakro the least warm (3777 Heat Index). Karachi and Ghorabari and hotter than Mirpur Sakro.

The above data alone will determine whether citrus or any other fruit or vegetable crops can be raised in Sindh. After thorough examination of climatic requirements of citrus. We have concluded that:

- Both Sindh and the Punjab are suitable for some or other varieties of Citrus.
- None of the two provinces is suitable for all varieties of Citrus.
- The Punjab is suitable for one group of citrus and Sindh of the other.
- Sindh has climatic advantages over the Punjab for some varieties of citrus and the Punjab has advantages over Sindh for other varieties.
- Sindh is not at all warm for a certain varieties of Citrus, for example; grape fruits, pummelo, limes a few varieties of oranges and a few types of mandarins. All these types of fruits need a high heat accumulation for good growth and yield and Sindh's weather can supply the required amount of heat.
- Rate of development of plants is closely correlated with Heat Index. This means that years of first fruiting of some varieties of citrus will be less in Sindh.
- Fruit development also depends on accumulation of Heat Indices. This mean that due to heat of Sindh, fruit will develop and mature earlier here.
- This years for growth and reaching maturation for maximum yield will also be less in Sindh.

- The distinction between early and late cultivars tends to disappear in warm areas and therefore Sindh cannot benefit much by raising late season cultivars.
- Maturation time for fruit is also reduced in warm areas i.e., from 8 months to 6 months for early cultivars and 11 months to 7 months for late cultivars. Thus Sindh will have an advantage of early harvests by at-least 2 months.
- In case of nurseries, the plants reach buddable stage in cold areas in 12 to 15 months and in warm areas only 9 months are sufficient.
- In case of early harvest of some fruits for example limes and grape fruits (in August and September in Sindh).. there is at least one vegetable flush in October. This helps in making trees bear regularly and not reducing the flowering and veiled in the next year. Thus trees bear more fruit over the years.
- The suitability of Sindh for citrus can also be verified from heat indices of other citrus growing areas of the India, and the World:
 - * Patna (Bihar) an important citrus area on 25°-30°N which is the same parallel as Tando Jam and Mirpurkhas has heat Index 3928 and Sindh could be equally important citrus producer.
 - * Dibrugarh another citrus area in Asam India on 27°N like Larkana and Khairpur, has Heat Index of 5019.
 - * Allahabad India has 5700 Heat Index and provides more heat than Sindh and yet it is a citrus centre.
 - * In India famous Nagpur Santra grows around Nagpur having maximum temperature of 46°C (like Dadu and Moro) and minimum coming down to 7°C.
 - * Mosambi grows in Khandesh and Poona (Pune) area of Maharashtra, having temperature range of 3°-46°C and is the principle sweet orange growing area. Acid lime is next important crops of this area.
 - * Sweet oranges and successfully raised in Deccan Plateau of India upto temperatures of 46°C. Citrus is raised upto temperature of 52° in Northern Rajasthan and Western U.P.

- * Imperial Valley (California) has heat index of 3377 and most of grape fruit of California is grown there. St. Louis (Florida) on 28°N, the Citrus centre of the state has Heat Index of 3468.
 - * Sindh's dry winter (humidity as low as 25-35%) can help in initiation of flowering buds the incidence of fungal growth, scab and other pests will be reduced.
 - * We have visited Allis Spring in northern Territory in the centre of Australian Desert. It is as warm as any place in Sindh and here they raise grape fruits, oranges, lemon, and Kumquats. Some varieties of mandarins are also raised. The Agriculture Extension Service of Northern Territory Australia promotes these crops.
 - * The average highest temperature^{4s} of Indio (Calif) and Citrus Research Station in Yuma and Tempe (Arizona) respectively are 41.6, 41.4 and 40.2°C and these temperatures are comparable to those of Larkana, Mehar and Nawabshah respectively.
 - * Dr. W. Reuther Prof. Emertius and editor of Citrus Industry Vol. I, II, III, IV and V wrote "In Cochlea and Yuma Valleys of U.S., various Eureka strains of lemons are grown fairly successfully on a commercial scale as are oranges. "In case of lemons only one bloom is produced in these hot desert areas and fruits ripens in September to December period." These are the views of World's top specialist of citrus fruits. Based on our own trials with citrus during the past 32 years, it has been proved to us that Sindh can raise grape fruit, oranges, limes and lemons successfully.
- Various stations of Sindh have heat indices between 4000-4500 except Karachi, Mirpur Sakro and Ghora Bari which have less than 4000 heat indices. Only Jacobabad has an average 4700 Heat Index. The Heat Indices of Sindh are between heat indices of Patna and Dibrugarh (India). The 3770 to 4000 Heat Indices of Sakro, Karachi and Ghorabari are within acceptable range.
 - Besides the Heat Indices and Chill Units also play role, the citrus needs average monthly mean temperatures over 13°C and below 38°C during the growing months. Larkana the coldest place in Sindh in number of Chill Units, has average temperature 13.3°C in January and Jacobabad the warmest place has average temperature of 38°C for June. It is true that high heat of the day hours may create partial dormancy in the hottest month in Sindh, but effect is only temporary and have observed profuse, flush in citrus in Tando Jam area at the end of June, after high heat of May. Bearas or Tahiti or Persian lime which flowers each month and fruits all year around has no flower flush in may in Tando Jam but end June flower flush is extremely profuse compensating for non-flushing in May.
 - One of redeeming factors of warm weather of Sindh is some 12-15°C difference in day and night temperatures expected through out the World deserts. In the whole World no other

vastly irrigated areas have this advantage and in those areas with low day and night temperature differences in warm months, there is a serious problem of:

- * High rates of respiration and transpiration at night.
- * Pigmentation of fruit does not take place and on the contrary coloured fruit may re-green.
- The most recent findings on growth temperature of citrus are that; at temperatures over 40°C (104°F) to 54.4°C (130°F) and under 13.2 to 0°C, the metabolic activity is very low in the plant and no active growth is present, but no damages are also observed. (Citrus growing in Florida by Larry K. Jackson, University of Florida 1991).
- Larger Fruit size is associated with high temperatures and specially the spring temperatures (Wardowski Wildfred F., Nag Steven and Grierson William "Fresh Citrus Fruits, 1986). High spring temperatures of Sindh can increase fruit size. Total Soluble solids and low sugar/acid ratio are also associated with high solar radiation. These special advantages of high temperature during the fruit set and its early growth were for the first time brought out by these authors.
- It is true that there is limited scorching of lamons and oranges directly exposed to sun, under those temperatures, but not those un-exposed or within the tree canopy.

Grape fruit.

Grape fruit has been grown in Sindh since the opening of Sukkur Barrage. It is harvested mostly in September, but as grape fruit can be stored on the tree, until March next year, harvest was spread over many months. One effect of storing fruit on the tree was, low yield in the subsequent year. It would be interesting to mention that citrus was successfully raised at Dokri, Dadu, Tharu Shah, and Pad-Idan, all of which are very warm places having the average maximum mean for the month of June at 41-6°C. Citrus can easily stand temperature of 50°C (122°F). Highest temperatures for Jacobabad and Pad-Idan are 48.5°C and 48°C respectively. Citrus can stand a few degrees below 0°C. Temperature in Sindh does not fall below 0°C. Grape fruit was also raised at Sakrand and Mirpurkhas comparatively less warm places. While grape fruit was harvested in Dokri, Dadu and Tharu Shah having 4400, HI (Heat Index) in September, in Imperial Valley (California) having 3300 Heat Index, it was harvested late in December-January period, a delay of 3-4 months. In the Central California (Bakersfield to Fresno) harvest took place still later, as these areas have less Heat Indices. The late harvest invariably affected yield of another young crop started for next season on the tree.

Oranges.

Naval Oranges need heat but less than grape fruit. It can be grown in Sindh as it needs high heat accumulation, as compared to other oranges.

Limes and Lemon.

Limes need heat and limes are successfully grown in Sindh. The Sindh's lemon is actually a lime. Limes need high amount of heat but not lemons. This crop gives more return than mango or banana.

Mandarins.

Sindh had its own mandarin the Narangi or Nargi from Portuguese "Naranj". It had a very interesting historical significance for its introduction in Sindh. By 1817 the British had gained paramony over the whole of South and East India. The Rajasthan, Kutch, Bahawalpur were also made the British protectorates. Mr. Karam Ali Khan Talpur, being afraid of the British designs, sought the Portuguese assistances from Goa and allowed them to establish a church on the Liari River on about 600 acre area. The Portuguese monks, introduced this citrus mandarin, on their property and from here it spread to Sindh. Narangi also gave Sindhi language this word, for orange colour. This mandarin was easy peeler and its segments automatically separated after peeling. Like original Naranj of Spain (Sour Orange), Narangi of Sindh was not sour. It may have been a mutant.

Pummelos.

Pummelos need high heat and cannot stand frosts. Pummelos do better on slightly saline water as well as saline soils. They also can stand water logging. Pummelos fruit has keeping quality of 4 months, during which it improves in flavour. The southern Sindh below Nawabshah is free of frosts and is ideal for this fruit. Pummelo is largest in citrus family reaching a size of 8 to 14 inches diameter. It is easy peeler and its segments can easily be separated. Even juice sacks can be separated from segments. It has great export potential in South East Asia, where its supply is in great demand, all the year around. In Pakistan citron is wrongly considered as pummelo, which has sweet juice and is not acidic like citron.

Citrus Industry of Sindh 1935-1960

- The Citrus Industry of Sindh flourished from 1935 to 1960 and then quickly disappeared. The causes of decline were many, except the commonly believed enemy, the weather. My own investigations based on local inquiries are:

- Plants were raised from seedling and unbudded seedlings besides producing inferior fruits, are prone to many viral and fungal diseases, causing sudden decline and death.
- In flood irrigation, root-rot is common problem, unless small three feet diameter and six inches high mounds are made around trunk of each plant so that roots are soaked rather than wetted by water.
- No chemical fertilisers existed and farm yard manure was the only fertiliser used. Applied over many years on the same crop, it created dis-balance between N, P and K at time plant needed the most and also between micro-nutrients. For example in its growth cycles at times plant needs only nitrogen and other times Phosphorus and Potash and all these are not available in manure, in required proportions.
- No plant protection chemicals were available and even if some chemicals were available, sprayers were not available. The whole job of plant protection was left to harmful insects and their natural predators.
- There was gradual rise of water table in Larkana, Dadu, Khairpur and Naushero Feroz districts which took the final toll. Water logging caused Root Rot and death of tees.
- Use of micro-nutrients to control some diseases was known but sprayers were not available. Hand operated knapsack sprayers or barrel sprayers became available in mid fifties, but these kitchen-garden devices had no place or capability to spray large trees.
- Instead of proper weed control, the only method resorted was inter-cultivation by spade or hoe, killing top roots many times a year and year after year, causing decline in production and tree vigour.
- Economic life of citrus trees is 30 years. Plants lived almost 20-30 years, before they were removed in early sixties.

Thus an early and premature death of citrus industry was caused in Sindh. The lime industry has lived until recently and we have witnessed with our own eye, its final death caused by water logging in Dadu and Naushero districts.

Conclusion.

- Sindh has wider daily temperature fluctuations, so citrus fruit produced will generally be brighter in colour and should have better flavour and sweetness.
- Cool climate of lower Sindh can allow virtually continuous harvest of lemons.

- Grape fruit can be grown the highest quality throughout Sindh.
- Red blush grape fruits will develop red skin blush, under high heat of Sindh.
- It is possible to raise citrus under shade of date trees in Sindh as heat and light are sufficiently intense, to allow citrus to be raised as inter crop.
- Fruit of most varieties of citrus will be larger size in the Sindh's heat and light, with exception of "Washington" Naval and "Satsuma" mandarin. The latter is not recommended for Sindh.
- The citrus is mostly sensitive tender to frost. The order of sensitivity to frost is: Limes, lemons, grape fruits, pummelos and tangelos. All these can safely be raised in Sindh, where frosts are a rare occurrence.
- In the hottest part of California, the Imperial and Coachila valleys, grape fruits of high quality, Valencia oranges, many varieties of mandarins, lemons and tangelos are raised. Since last two years their parts get too cold in winter, citrus in these areas of California lose its colour. In Sindh the winter temperatures do not reach such extreme. These crops have very bright future in Sindh.

There are a few musts in successful citrus growing.

Citrus gives yield of 20 to 25 tons/acre in California, Florida, South Africa and Australia. In Pakistan the yield is only 3-5 tons.

The yield losses occur due to the following causes:

Causes	Percentage
Weed competition.	25-30%
Improper nitrogen fertilisation (too much or too little).	10-25%
Wind injury.	30-35%
Scales.	10-15%
Melanose.	20-23%
Rust.	4-5 %
Total losses about	75%

Further loss due to rejection of fruit from farm to the consumer is 5%.

Having understood these factors, the new citrus farmer of Sindh will be ready to raise following citrus varieties:

- Grape fruit (all varieties).
- Oranges (Naval and Valencia).
- Limes (Some varieties).
- Pummelos (all varieties).
- Mandarins (some varieties).
- Tangelo (all varieties).

If improved agronomical practices are introduced and proper cultivars in each varieties are selected, progressive and educated farmers, who besides farming also keep them-selves technically up to date, can expect a yield of at least 15-20 tons/acre. As a farmer, I am aiming at 20-25 tons/acre.