

**Proceedings:**

International Symposium on  
Prospects of Horticultural Industry in Pakistan  
28<sup>th</sup> to 30<sup>th</sup> March, 2007  
Institute of Horticultural Sciences, University of Agriculture, Faisalabad

## ECOLOGICAL NEXUS FOR THE QUALITATIVE PRODUCTION OF CITRUS FRUITS

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**Abstract**

It is an established fact that in the present arena of global trade; no compromise on fruit quality is permissible by the importing countries of the world. From quality view point suitable nexus between cultivars and agro ecology is very important. Citrus fruits although enjoy wide range of climatic adaptability but qualitative yields are only possible to attain in the areas which are most suited for the development of exterior and interior quality characters particularly when the fruit is developing/heading towards maturity periods. Among various meteorological ingredients 'heat unit' for different fruit varieties are very important to study as they indicate the availability of functional heat required for fruit maturity and other phenological attributes of different cultivars. By developing heat indices for different fruit varieties ecological niches pertaining to the various citrus cultivars of indigenous/exotic ones can be developed to prevent the haphazard approach of citrus cultivation. At Horticultural Research Station, Sahiwal heat indices for different cultivars have been developed which can be helpful to produce better quality fruit thereby paving the way for developing agro ecological delineations for different citrus cvs. This is high profile work that was long over due to carry out as a part of good agricultural practices (GAP) identifying the poor and the good areas for citrus production.

**Key words:** Heat units, degree days, cultivars, mandarins, sweet orange, grapefruit, tangerine, tangelo.

**INTRODUCTION**

Citrus is though adaptable to a wide range of Agro-climatology but at the same time it is vulnerable to microclimatic conditions of a certain area. Among microclimatic conditions temperature constitutes to be the key element not only affecting the growth but various other phenological stages of the plants. In the present trade scenario quality of fruit have assumed ever increasing significance which has necessitated to raise citrus in eco-friendly areas besides taking care of other factors conducive to better yields and fruit quality. Realizing the significance of heat units; an elaborated work has been reported by various scientists (Sarvestava and Singh, 2002) were of the view that temperature changes are more precisely understood when expressed in terms of Degree days (GDD). These can be calculated using formula

$$G.D.D = (M-13) \times N$$

Where “M” stands for mean monthly temperature, 13 base temperature and “N” is the number of days of the relevant month. Rajput and Harribabu (1985) reported that heat units of growing season have been calculated from areas in United States for grapefruit as 5617-6781, Washington Navel orange 2706-3462, Valencia oranges 2672 and for lemons 1854. While, developing a methodology for determining heat unit requirements for the harvest of Blue berry (Carlson and Cock, 1991) reported that heat unit system can be used for a wide range of crops including those in Horticulture. The significance of heat units was discussed by Nick, 2006 to obtain adequate sugar (°Brix) levels. He explained that ‘Orlando’ requires 3700 heat units in Florida, River Side 1700. In New Zealand annual heat units ranged from 700-800, so Valencia late do not perform in low heat unit areas. However varieties like Satsuma perform qualitatively well using trifoliolate orange as a rootstock.

## MATERIALS AND METHODS

For data base temperature data were ascertained from provincial meteorological observatory at Sahiwal and from other trialed areas i.e. D.G. Khan, Bahawalpur, Soon Valley (Noshehra) etc. Daily maximum and minimum temperature was ascertained from these areas and heat units were calculated according to the following formula taking base temperature for citrus as 13 at Celsius.

$$\text{Days of the relevant month} = \left( \frac{\text{Maximum} + \text{Minimum}}{2} - 13 \right)$$

A wide range of local cultivars and of exotic region was the part of the study. These varieties were Salustiana, Marss Early, Casa Grande, Hamlin, Navelina, Kinnow, Feutrell’s Early, Clamentina, Shamber, Red Blush, Star Ruby and Flame. All of these cultivars/varieties were clubbed in different categories according to the classified groups.

## RESULTS AND DISCUSSION

Heat units of different citrus growing area and other probable areas of citrus such as D.G.Khan, Chakwal and Soon Valley areas were calculated accordingly to the method adopted universally. Heat units on the basis of five years data of the said areas have been produced in T<sub>1</sub>. The table clearly depict that Sahiwal accumulated maximum heat units of 4642.94 whereas Soon Valley accumulated minimum heat units of 2873.93 degree days.

In addition to that a relationship has also been developed on the different quality characters of some commercial citrus cultivars as Kinnow, Feutrell’s Early, Musambi, Salustiana, Marss Early Casa Grande, Fairchild, Shamber, Red Blush, Valencia late, Minneola and Fremont, Hamlin, Blood Red and Tarocco (Table 2 to 6)

**Table 1:** Heat units and altitude values at different locations

Areas	Altitude (feet)	Heat Units (degree days)
Sahiwal	554	4642.94
Bahawalpur	380	4584.36
Chakwal	2600	3413.88
D.G.Khan	450	3226.83
Soon Valley	4000	2873.93

**Table 2:** Heat units and quality characters of mandarin varieties under Sahiwal conditions

Variety	Heat units (degree days)	Quality Characters		
		TSS	Acidity	Acid Ratio
Kinnow	4118.00	12.03	0.65	18.92
Feutrell's Early	3984.59	10.00	0.69	14.92

**Table 3:** at units and quality characters of sweet orange varieties under Sahiwal conditions

Variety	Heat units (degree days)	Quality Characters		
		TSS	Acidity	Acid Ratio
Musambi	4169.23	11.00	0.45	24.44
Salustiana	3826.82	11.40	0.51	22.35
Marss Early	3402.17	10.30	0.50	20.60
Casa Grande	4446.38	10.20	0.50	20.40
Valencia late	5153.16	08.20	1.06	07.90
Hamlin	4250.38	11.20	0.63	20.80
Blood Red	4334.70	11.00	0.70	15.71
Tarocco	4404.38	10.00	0.52	19.23

**Table 4:** Heat units and quality characters of grapefruit varieties under Sahiwal conditions

Variety	Heat units (degree days)	Quality Characters		
		TSS	Acidity	Acid Ratio
Shamber.	4304.48	09.30	1.00	09.30
Red Blush.	4455.92	09.60	1.35	07.10

**Table 5:** Heat units and quality characters of tangerine/tangelo varieties under Sahiwal conditions

Variety	Heat units (degree days)	Quality Characters		
		TSS	Acidity	Acid Ratio
Fairchild tangerine.	4169.23	10.40	0.97	10.97
Fremont tangerine.	3631.32	11.20	1.13	09.91
Minneola tangelo.	4602.80	07.60	0.68	11.00

The results observed in preliminary studies clearly depicted that Mandarin, Tangerine and tangelo cvs. can be successfully grown in central and southern Punjab whereas navel oranges are absolutely unsuitable. Moreover, citrus belt can be widened toward northern Punjab particularly for barani areas where annual heat unit accumulation ranged from 2873.93 (Noshehra) to 3413.88 (Chakwal) with the corresponding altitude of 4000 ft and 3226.83 ft respectively. Valencia oranges and grapefruit cvs. (Shamber & Red blush) accumulated fairly high number of heat units i.e. 5113.36, 4455.92 and 4304.48 respectively producing good internal quality characters. Studies reported herein stands corroborative to the finding of Nick, 2006 according to whom adequate sugar levels were obtained in high heat index area (3700 heat units). These studies also confirm that Valencia Late in low annual heat units did not perform well. The work on heat units also fall in line to the findings of Rajput and Harribabu, 1985 that grapefruit can be grown in high heat index area ranging from 5617-6781 and Washington Navel 2706 to 3462 degree days.

## SUMMARY

Ecological security is paramount for the qualitative production of citrus fruits about which development of climatic norms besides deep fertile soils, good quality of irrigation water, compatible rootstocks and suitable production technology is the dire need of the day. Delineation of cultivar specific pockets in the background of the advent of new citrus cultivars can effectively be made developing heat units for which preliminary work has been carried out at Horticultural Research Station, Sahiwal. Besides heat units different cultivars require some other meteorological ingredients like that of humidity, sun shine and even transmittance of photo-synthetically active radiation (PAR) and a fair amount of chill for triggering flowering phenomenon for initial fruit setting. However, for all phenological stages significance of temperature determined in the form of heat units stands all the more paramounts. In realization of the significance of functional heat necessary to mature citrus fruits for ensuring better quality is unquestionable. Responding to this important issue preliminary work reported in this write up has been undertaken at Horticultural Research Station, Sahiwal which would be kept continued for identifying the most congenial areas for citrus production simultaneously ensuring the better quality of the fruit for domestic and off-shore citrus trade. Summing up the summary of the studies, following points have been felt to produce necessary for establishing suitable ecological nexus for various citrus cultivar:-

1. Seedless cultivars of sweet oranges particularly Salustiana, Marss Early and Tarocco may be grown successfully in the northern Punjab.
2. Except Star Ruby Grapefruit all other pigmented and seedless grapefruit may be grown in central and southern Punjab.
3. For Tangerine and Tangelo (Fairchild, Fremont, Minneola etc.) desert type climate should be preferred.
4. In the area of high altitude cultivation of easy peel mandarin particularly the Clamentine may be encouraged.
5. For Kinnow mandarin semi-arid and sub-tropical climate with cool winter nights and sunny warm days during October and November are very necessary with the uniform relative humidity between 65 to 70%.
6. Basin shape valleys to accumulate cooler should be avoided for the cultivation of acid lime due to frost hazard.

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