Effect of High of Temperature on Fruits and Ornamental Crops
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Effect of High of Temperature on Fruits and Ornamental Crops

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The effect of global warming is now visible in many parts of the world. Abnormality in climate patterns, induced by accelerated warming, has started to affect a catchment-species chydrologic cycle. Higher temperatures lead to a high rate of evaporation and dry conditions in some areas of the world. The effect of high temperature on different growth stages (phenology) of fruit crops is summarized under following under sub-heads:

- Vegetative growth
- Flowering
- Fruit yield
- Fruit quality
- Disorders
- Metabolic processes

Vegetative growth

Under high temperature exposure (43^0 C) in almond bud failure like symptoms appear in which there is complete separation of distorted and compressed cells from surrounding tissues takes place by a periderm like layer. Higher temperature in temperate fruits can negate the chilling effect. In apple, the trees, which were exposed to daily alternating temperatures, had lower levels of bud break (vegetative), when the high temperature in the diurnal cycle was greater than 14^0C. Practically no bud break was apparent on trees that were exposed to diurnal cycles with a high temperature of 20^0 C for 8 hours. In raspberry, the optimum temperature for node production is 22^0 C and it continues to support growth up to the range of 20^0 C. Above this range, it becomes supraoptimal and node production is reduced. Mango cultivars exposed to higher temperature showed that vegetative growth increased with increasing temperatures. Likewise, mango, higher temperatures in citrus also enhances vegetative growth but after certain limit, it retards the shoot

elongation. Troyer citrange and Valencia oranges showed that seedlings were with short internodes and leaves were markedly shorter as compared to normal ambient temperature (28/22^{0}C). Beside the effects of high temperature on whole fruit trees, some examples are desiccation of leaves in Baramasi lime and young leaves of newly planted guava plants wilt and die during hot summers. Many a times pear on kainth rootstock newly-planted plants dries up during May-June due to desiccation.

Flowering

The various stages starting from flower bud differentiation, anthesis, rate of flowering and even development of various parts of flowers is influenced by the prevailing environmental temperature. Lack of chilling associated with mild winter conditions results in abnormal pattern of bud break and development in temperate fruit trees. After strict deprivation of cold temperature in peach all floral primordia died within 5 months. In red haven peaches grown at 20/15^0 C from October to December, it was found that the bud necrosis could be attributed either to the weak establishment of vascular connections between stem and floral buds or the unavailability of the sugars. However, the sugars *viz*., sorbitol and sucrose concentrations remained high in cushion and bud scales but low in floral meristem. Thus, it seems that under high temperature the bud scales and cushion beneath the meristem primordia served as strong sink as compared to meristem. The temperature rise at the end of January in apricot (during the period of rapid floral development) appears to increase the flower bud abscission. In most fruit crops, generally higher temperature decreased the days interval required for flowering and cooler temperature though required more days for flowering but the number of flowers produced increased proportionally at this temperature. The rate of flowering in raspberry cv. Autumn Bliss was dependent upon temperature. The flowering in primocane raspberry cultivars is initiated by the cessation of vegetative growth. Growth of plants at 24.5^0 C slowed earliest after just less than 100 days but at temperature below or above this, the cessation of growth was delayed. In citrus (*Citrus unshiu*), the flower number at an air temperature of 15^0 C were greater than at 30^0 C. In sweet cherry, there is abnormality in pistil development, if the flower bud development period (mid July) exposed to higher temperature (35^0 C). While evaluating the effect of temperature on flowering of peaches, it was found that the period of full bloom with treatments of 25/15 and 30/15^0 C were 5 and 8 days earlier, respectively than for the 20/15^0 C treatment. With the increase in temperature, rate of pollen development

and tendency for the stamens to abort increased. Temperature not only influences the development of various parts of flowers but also determines the type of inflorescence. In litchi cultivars, when trees exposed to day/night temperatures of $30/25^0$ C and $25/20^0$ C did not flower and temperatures of 20/15 and $15/10^0$ C gave rise to variable proportions of vegetative, leafy panicles and leafless panicles depending on the cultivars. Similarly, in citrus, more leafless floral shoots are produced at cooler temperature (20/ 15^0 C day/night) and higher soil and air temperature enhanced production of leafy floral shoots.

Fruit set and Yield

Fruit set and yield in fruit crops are directly related with the environmental temperature. Likewise, in apple and pear low temperatures appeared to promote fruit set on potted trees to different temperature regimes from February to harvest. In apricot, at higher temperature, the pistil size is reduced which leads to abnormal flower and ultimately reduced fruit set. In Cherimoya (tropical fruit), the effect of warm ($30/25^0$ C) and cool ($20/15^0$ C) day/night temperatures on fruit set and fruit growth the low fruit set at warm temperature regime was ascribed to both pollen and stigma damage from heat stress. Beside pre-blossom and blossom temperature, the higher temperature during fruit set stage also affect the fruit retention. The fruit set in soft pear and peaches is reduced due to sudden rise in temperature.

Fruit quality

Quality is a measure of degree of excellence or degree of acceptability by the consumer. It includes external parameters (color size, shape and defects) and internal parameters (texture, flavour and nutritional qualities).

External parameters

Natural colour development in fruits is one of the external quality parameters visibly sought after by the consumer. High temperature generally reduces the anthocyanin accumulation in fruit crops. In grapes, version is a critical period for the berry tissues to perceive environmental stimulation and trigger anthocyanin biosynthesis. At this stage, night temperature is more critical than the day temperature. Anthocyanin synthesis in the skin of berries grown at high night temperatures (30^0 C continuous day and night) is reduced as compared to that of berries grown at low night temperatures ($30/15^0$ C ; day/night). Fruits of Cavendish banana subgroup failed to degreen, when ripened at the high temperatures of the tropics (>24^0 C). The fruits remained green because of the retention of chlorophyll and associated thylakoid

lamellae in citrus, if mature fruits are left on the trees during summer months, chlorophyll returns to rind and carotenoid content decreases. This condition is referred to as regreening, degree of which is influenced by high temperatures.

Internal parameters

Kiwi fruit grown under high temperature (3-4^{0}C more than the ambient temperature) during mid-march to mid may had lower soluble solids, more firmness and had higher starch concentrations in both core and cortex tissue. However, in the grapes also a vine crop, the soluble solids content increased with the increase in temperature from 15 to 30^0 C.

Disorders

Early water core of apple cultivars in which there is sorbitol accumulation takes place is increased by high temperature above 30^0 C during the summer.

The resistant cultivar 'Fuji' showed a difference in sugar compartmentation and higher fructose and glucose in the vacuoles. Conversely, the susceptible 'Orin' apples had higher sorbitol level in cytoplasm and tonoplast. These results implied that higher fruit temperature may increase tonoplast permeability especially to sorbitol in the early water core susceptible 'Orin' cultivar but not in resistant 'Fuji'. Similarly, higher temperature grown fruits, when stored at 3^o c, here is breakdown incidence. In pear also, the higher temperature accelerates the development of water core in pineapple, translucency of fruits is most encountered disorder in which the flesh gives water-soaked appearance. It is a hindrance in the fresh marketing of fruits.

The incidence of the disorder is correlated with both higher (28/18^0 C, max/min temperature) and lower (23/15^0 C) 3 months preceding the harvest. Albinism of strawberry is a serious disorder, which has attained alarming situation in USA, Belgium and Netherlands. Fruit suffering from this malady appear blotted and develop pink or white areas on their surface, the pulp remains pale. It occurs frequently in the fields during peak fruit production in localities experiencing warm weather. This disorder is also favored by black polythene as it raises the soil temperature.

Metabolic processes

High temperature also has a direct effect on the processes like respiration and photosynthesis. In mango, with the increase in temperature from 15 to 35^0 C, the photosynthesis rates increased. However, the photosynthesis rates decreased, when the temperature was increased further at the same vapour pressure deficit.