FRUIT GROWTH AND DEVELOPMENT IN THREE CULTIVARS OF CITRUS: ORANGE, KINNOW AND FEUTRALL'S EARLY

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Abstract

Sweet Orange (*Citrus sinensis*) and two varieties of Mandarin; Kinnow and Feutrall's early were studied for their fruit growth. For this purpose an experiment was conducted at National Agriculture Research centre (NARC), Islamabad during the year 2008. Gravity method was used to determine the cell division and cell enlargement. Feutrall`s early, Kinnow and Sweet orange cultivar "Salustiana" exhibited a sigmoidal growth pattern. A significant variation in fruit size was observed among the three fruits. Feutrall`s early had the smallest fruit size (48.23mm), Kinnow and Sweet orange cultivar "Salustiana" had fruit size of 59.43 and 68.45 mm, respectively.

Introduction

Citrus is an economically important group of fruit crop, with highly nutritive fruits (Hussain, *et al.,* 2004) especially rich in minerals and vitamin C (Supraditareporn &. Pinthong, 2007). In Pakistan, kinnow and sweet orange being the most important members in terms of area of cultivation and fruit production (193212 hectares with a production of 1472471 tons/year) (Anonymous, 2008) has acquired the status of an industry (Chaturvedi *et al*., 2001). Kinnow is a prolific variety and gives some 800 hundred fruits per tree (Ali, 2005). About 80% of the citrus produce in Pakistan comes from kinnow and Feutrall Early. Khan and Shaukat (2006) have reported that during 1957-58 to 2002-03, citrus yield in Pakistan varied from 6.051 (1958-59) to 12.03 tonnes ha^{-1} (1964-65) averaging to 9.76 $\pm$ 0.18 tonnes ha^{-1} with variability around 12.4% and the increase in citrus production through years is mostly related to the area under cultivation and not the yield. The sweet Oranges (*Citrus sinensis* (L). Osbeck) may develop 250,000 flowers per tree in a bloom season although only a small number, usually less than 1 %, becomes mature fruit (Goldschmidt and Monselise, 1977). The floral load depends on the cultivars, tree age and environmental conditions (Monselise, 1986). The abscission of flower and growing ovaries depends on source sink balance and hormonal regulation (Gulsen *et al*., 1981, Bustan *et al.,* 1995) and prevailing environmental condition (Reuter, 1973). Flower bud induction occurs during the cold and dry weather condition in December and January. A shoot flush is usually initiated in spring, when the temperature rises above 12.5°C (Davies and Albrigo, 1994) or after alleviation of water stress. This is followed by a summer flush approximately three months later. Little substantial vegetative growth occurs during the rest of the year, particularly in subtropical or Mediterranean areas (Syvertsen *et al.,* 1981). The spring flush (March to April in the northern hemisphere) is usually more intense, affecting more growing points than the summer flush (July to august). The phonological stages of citrus fruit generally follow a typical sigmoid growth curve, divided into three distinct phases (Bain, 1958). The initial phase (Phase I) is characterized by slow growth, comprises mainly cell division and may last for hast two-month. Thereafter, a rapid growth period due to rapid cell enlargement and water accumulation during four to six months (Phase II). Therefore, developing fruitlets utilize reserves during the cell division period and store during cell enlargement (phase II) (Mehouachi *et al*., 1995). Phase II is followed by maturation (Phase III). The identification of phenological stages of a crop in a in given locality is of prime importance in management practices such as fertilizers application, pruning, irrigation, monitoring pests and diseases etc (Tajero *et al.,* 2010) and modeling fruit growth (Mechlia & Carroll, 1999). Keeping in view the importance of citrus, the physiological changes as affected by climate, soil moisture and nutrients are associated with flowering, crop load and cropping in fruit trees.

Materials and Methods

This study was carried out in the citrus orchard of Horticultural Research Institute (HRI) at National Agriculture Research Center (NARC), Islamabad during the year 2008.

Two mandarin cultivars "Kinnow and Feutrall`s early" and one Sweet orange cultivar "Salustiana" were used for the study. The branches for collection of fruits were selected on all four sides of the tree canopy and tagged. The data was recorded on weekly basis.

The data on fruit cell division was started immediately after the petals fall. The fruit cell division and enlargement were evaluated with the help of gravity method. In this method ten fruits each from sweet orange, Feutrall`s early and Kinnow were taken randomly every week. The fruits of each species were placed a jar full of water. The fruit undergoing cell division sink at the bottom while those in cell expansion phase float in water.

The size of the fruit was evaluated with a digital vernier caliper and the cell expansion was considered to be ceased when there was no further increase in the size of the fruits.

Results and Discussion

Growth Pattern: The study of a crop helps in strategic management of the tree and identifies the adequate time of fertilization and other cultural practices (Tajero *et al*., 2010).

The study of citrus species revealed that sweet orange, Kinnow and Feutrall's early generally followed a sigmoid growth curve, with three distinct phases of cell division, cell expansion and maturation as reported by Bain, (1958) and Mehouachi *et al*. (1995).

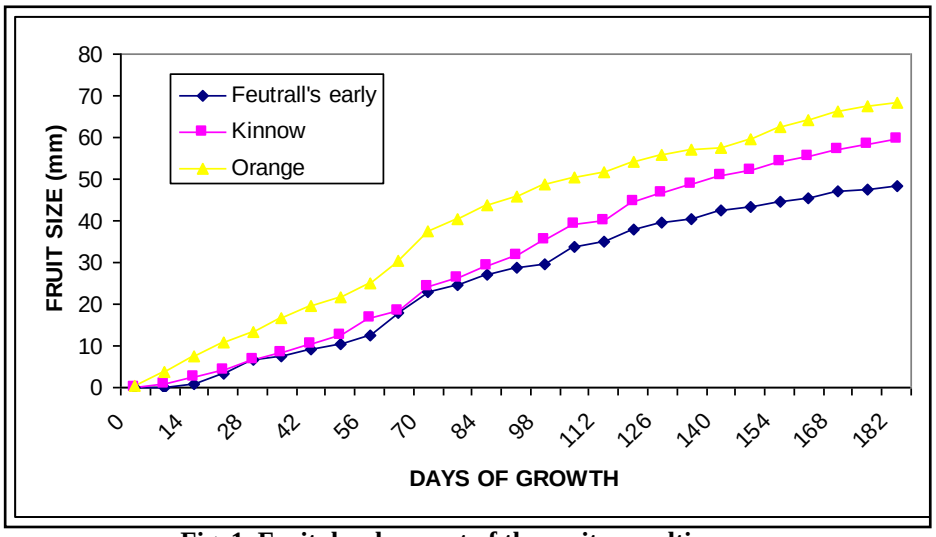

Fig. 1. Fruit development of three citrus cultivars

The Timing of stages

The cell division phase: The phase of cell division started in Salustiana orange on April 03rd with a fruit size 0.5 millimeter followed by Knnow on April 10th with a fruit size of 0.65 millimeter and finally the Feutrall`s early fruit on 17th of April, with fruit size 1 millimeter.

Thus among the three species tested Salustiana orange were the earliest while Feutrall`s early was the last to initiate cell division.

The cell enlargement Phase: The cell enlargement phase in Salustiana oranges started on 5th of June; the fruit size was 24 millimeter and continued till 3rd of October with a final fruit size was 68.45 millimeter. In kinnow fruit cell enlargement stage was recorded on June 12th with the fruit size was 24mm and last data was recorded on 3rd of October with a final final fruit size of 59.43 millimeter. Cell enlargement iniated a week later in Feutrells early (June 12th with the fruit size of 23.05 millimeter and finally reaching the size of 48.23 millimeter. The metabolic activities and subsequent growth of a species depends on various environmental factors. Since the temperature in Pakistan generally increase after the spring, the rapid growth could be attributed to the influence of temperature (Kimball, 1984).

Table 1. Quadratic equation representing relationship among cultivars.

Citrus	a		b		c	R^2	P-Value	Remarks
Feutrall's early	-7.830	+	0.4853	-	0.009	0.9912	P< 0.001	Highly significant
Kinnow	-5.888	+	0.4637	-	0.0005	0.9992	P< 0.001	Highly significant
Orange cv. Sulustiana	-1.7527	+	0.6168	-	0.0013	0.9927	P< 0.001	Highly significant

The relationship in fruit growth among the three citrus cultivars may be due to same genus and same climatic conditions in Islamabad. It was observed that Feutrall`s early, Kinnow and Sweet orange cultivars

"Salustiana" exhibited a quadratic relationship. A significant variation in fruit size was seen among the three. Feutrall`s early gained the smallest fruit size (48.23mm) till last data, Kinnow and Sweet orange cultivar "Salustiana" gained an average fruit size of 59.43mm and 68.45mm respectively.

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