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Seasonal Changes in Fruit Growth Pattern and Quality Parameters in nectarine cv. Silver King

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ABSTRACT
An experiment on seasonal changes in physic-chemical parameters of nectarine cv. Silver King was conducted at experimental farm of department of Fruit Science, college of Horticulture, Dr Yashwant Singh Parmar University of Horticulture & Forestry, Nauni, Solan (H.P.) with 11 treatments i.e. the observations taken on 7 days after full bloom (DAFB) considered as 1st sampling date (D1) to 77 days after full bloom (D11) at weekly interval. In that way, there were 11 sampling dates beginning with 7 days after full bloom (DAFB) to 77 DAFB replicated 4 times and the experiment was laid out in Randomized Block Design. The results revealed that the fruit growth parameters viz., fruit weight, volume and fruit size (length & diameter) exhibited characteristic of double sigmoidal curve. In nectarine cv. Silver King, the fruit development processes followed a specific growth pattern- in which fruit after setting showed a exponential fast growth till 28 days after full bloom followed by slow growth till 49 days after full bloom which is also known as pit hardening stage and finally also ensured a fast growth till physiological maturity. The quality parameters viz., total soluble solids, total sugars and reducing sugars also followed similar trends of double sigmoid curve; whereas, the titratable acidity increased up to 49 days after full bloom and thereafter declined gradually.
***Key words**: Nectarine, Peach, sigmoid growth curve, fruit development, Silver King*

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INTRODUCTION

Nectarines are being grown between 30^{0}N to 40^{0}S at an altitude approximately upto 2000 meters above mean sea level. Nectarines performed better in the temperate zone of the country where the necessary chilling hours met adequately. Basically, nectarines are the peaches which developed through mutation and found lack of fuzz by virtue of which they are attaining a special attraction to the consumers. Silver King cultivar of nectarine arose as a mutant of an unnamed cultivar in France in 1975. Due to attractive colour and size it becomes a choicest fruit for stone fruit growers.

In India, the peaches occupied an area of 18,000 hectare with an annual production of 1, 07,000 MT. Among the states, Uttarakhand covered highest 54% area while, Punjab, Jammu and Kashmir and Himachal Pradesh occupied 30%, 9% and 6%, respectively [4]. In recent times, the cultivation of nectarines, a fuzzless peach is popularizing in the mid hills of Himachal Pradesh.

The nectarine fruit is new introduction in the mid hills of the Himachal Pradesh. The vegetative parameters such as number of shoots, number of leaves, leaf area etc. influenced the physico- chemical properties of the fruits. The behavior of fruit development changes have a unique pattern and may also have some influence on the quality attributes of the crop. The development of new leaves improves the assimilate supply as the greater amount of photosynthetic leaf area on the fruit bearing shoots with vegetative growth could explain the higher fruit size at harvest [5]. Therefore, efforts have been made to study the seasonal changes in fruit growth stages and quality parameters in nectarine cv. Silver King.

MATERIALS AND METHODS

An experiment was conducted at the experimental orchard of Department of Fruit Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) during the year 2010 and 2011.The

experimental farm is located at an elevation of 1260 meters above mean sea level. Six year-old nectarine plants of cultivar 'Silver King' raised on wild peach seedling were selected on the basis of uniform vigour. The plants were trained to open centre system and planted at a spacing of 3 x 3 meters. All the recommended cultural practices were followed and were kept uniform during the entire course of the investigation during both the years. The experiment was laid out in Randomized Block Design. Sampling dates were considered as treatments and were replicated 4 times. The fruit physical characteristics were recorded at weekly interval beginning from 7 days after full bloom (DAFB) i.e. D1 to 77 DAFB i.e. D11; thus, there were 11 sampling dates/ treatments. The fruit quality parameters were observed from 4th sampling date i.e. D4 (28 days after full bloom) to D11 i.e. 77 days after full bloom. The fruit growth parameters, the fruit size in terms of fruit length and diameter were recorded with vernier caliper on each sampling date from randomly selected fruits and expressed in centimeters. The fruit weight of ten fruits was recorded on electronic balance and the average of the results was expressed in grams. The fruit volume was measured by water displacement method. Ten selected fruits taken for measuring weight were immersed in a measuring cylinder filled with water to obtain certain graduation. The difference between initial and final readings gave the measurement of volume of fruit samples, which were averaged and expressed in cubic centimeter per fruit.

The total soluble solid contents in fruits were determined by Erma hand refractometer (0-32^{0}B). The total soluble solids were expressed in degree brix (^{0}B). The titratable acidity was calculated by titration method in which 25g of pulp was thoroughly mixed with distilled water to make the final volume 250 ml. The titration was done with N/10 NaOH solution using phenolphthalein as an indicator. The titratable acidity was calculated in terms of malic acid and expressed as per cent on pulp weight basis. The total sugars and reducing sugars was calculated as per the method given by A O A C [1] method and the results were expressed as per cent on pulp weight basis.

RESULTS AND DISCUSSION

Fruit Physical Parameters

The graphical representation of the data (Fig.1) showed that the fruit physical parameters i.e. fruit weight, volume, length and diameter registered an exponential increase up to 28 days after full bloom (DAFB). This period of rapid growth was termed as phase I. After 28 DAFB, slow increase in physical parameters was noticed until 49 DAFB which was recognized as phase II. After the slow period of growth a rapid growth phase was also noticed, which was marked as phase III.

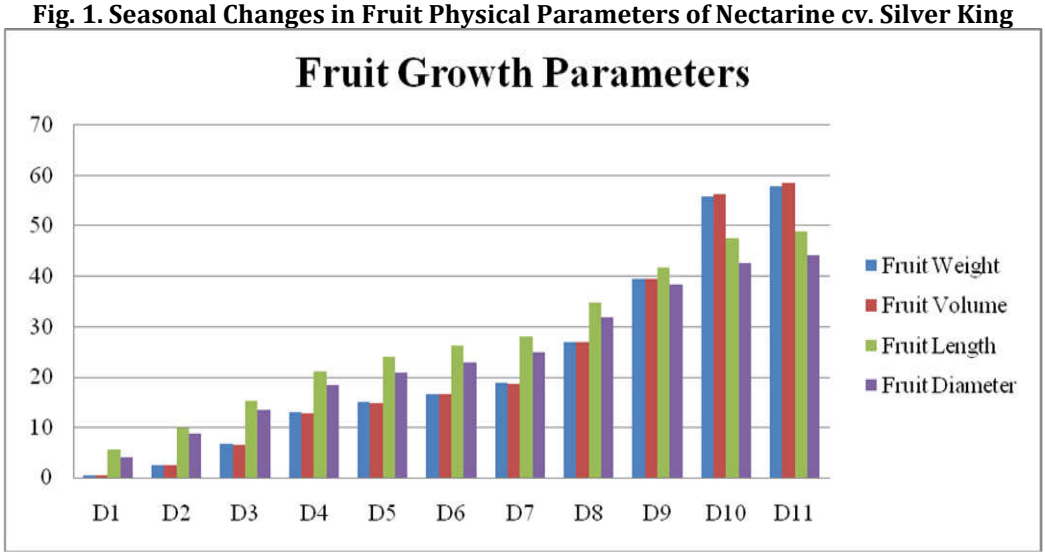
Pooled analysis of data revealed similar trend in increase in fruit weight during in both the years under study. The highest (57.81 g) fruit weight was recorded on last sampling date i.e., 77 DAFB, which was found to be statistically at par with 10th sampling date (55.91 g) i.e., 70 DAFB. The fruit volume exhibited almost similar trend as that of the fruit weight. The fruit volume showed rapid increase initially but at beginning it ran slightly lesser pace. Thereafter, it increased slightly than fruit weight. The fruit volume ranged from 0.42 cm^3 to 58.58 cm^3 among all the sampling dates. The highest fruit volume 58.58 cm^3 was recorded on last sampling date i.e., 77 DAFB, which was found to be statistically at par with 10th sampling date (56.41 cm^3) i.e., 70 DAFB.

Data pertaining to fruit length and diameter was also illustrated in Fig. 1. The data recorded on fruit length and diameter showed characteristic of double sigmoid growth as similar as described in fruit weight and volume. The fruit length and diameter increased significantly till 28 days after full bloom and sustained upto 49 days after full bloom; after that registered a significant increase upto 70 days after full bloom. After 10th sampling date i.e., 70 DAFB non- significant increase was noticed in fruit length and diameter. Although, the highest (48.82 mm) fruit length was recorded on the last sampling date i.e., 77 DAFB (D11), which was found statistically at par with D10 (47.48 mm). The highest (44.22 mm) fruit diameter was recorded on the last sampling date i.e., 77 DAFB, which was found statistically at par with 10th sampling date (42.71 mm). Bollard (1970) reviewed the concept of cyclic growth of stone fruits during period I i.e. the initial period of rapid growth, the pericarp and seed increase in size and weight. In the pericarp, there is usually a period of cell division which is followed by rapid cell enlargement. In this period, the endocarp and seed reach almost full size. The nucellus and integuments grow rapidly and cease growth at the same time as the mesocarp. In the second period (Phase-II), the overall growth rate slows down markedly and there is initial rapid hardening of the endocarp. He observed that slowing down of fruit growth is essentially due to the retardation of mesocarp growth. The embryo develops rapidly and reaches to maximum size during this period. Period III is a period of 'final swell' during which growth in size and weight resumes a rate approaching that of period I. There is usually an increase in both cell size and amount of intercellular space in the flesh. Ripening of the fruit occurs towards the end of this period. DeJong and Goudriaan [9] also reported double sigmoid growth pattern in peach cvs. June Lady and O'Henry and found that only two physiologically distinct phases of sink activity that were

traditionally recognized instead of three stages. The traditional stage II of fruit growth was apparently a function of the timing of the shift between these two physiological phases of sink activity.

Kurnaz and Kaska [10] observed that the increase in fruit weight and volume showed double sigmoid curves in peach and nectarine cultivars. They also noticed that fruit flesh density increased rapidly from the end of stage II to the beginning of stage III and thereafter, decreased. Bhatnagar and Kaul [5] observed double sigmoid growth curve in low chilling peaches cvs. Pratap, Flordasun and Shan-i-Punjab. They noticed three distinct fruit growth phases i.e. Phase I with rapid growth (10 to 40 DAFB), Phase II with slow growth (40 to 60 DAFB) and Phase III with faster growth (60 to 80 DAFB). Yamaguchi *et al.* [12]) noticed in peaches that the duration of each growth stage differed among the cultivars, especially Stage II. The fruit growth after the cessation of cell division was dependent on cell enlargement. They also found that mesocarp cells did not grow uniformly during Stage III; rather, the radial cell length near the stone was greater than that of outer portions. Flesh cells continued to divide for 4-5 weeks after full bloom and increased in size thereafter.

Fig. 1. Seasonal Changes in Fruit Physical Parameters of Nectarine cv. Silver King



Fruit Chemical Parameters

The observations recorded on the fruit chemical parameters revealed that the fruit total soluble solids, total sugars and reducing sugars also followed the trend of double sigmoid curve (Fig. 2). While, the fruit titratable acidity (Fig 3) increased till D7 (49 DAFB) and thereafter lowered down gradually. The analysis of Pooled data for both the years showed that the highest (14.14 ^{o}B) total soluble solids was recorded at D11 (77 DAFB) which was statistically at par with D10 (13.90 ^{o}B). The highest total sugars and reducing sugars i.e. 9.24 % and 3.97 % were recorded on D11 (77 DAFB) followed by D10 (8.91 %; 3.68 %, respectively) in Silver King cultivar of nectarine. Whereas, the highest (0.84 %) titratable acidity was recorded on D7 (49 DAFB) which was statistically at par with the sampling done at 56 days after full bloom i.e. D8 (0.79 %). Singh and Kanwar [11] noticed that fruit quality in terms of total soluble solids (TSS), acidity, TSS: acid ratio and firmness was better on the vigorous shoots in peach cv. Shan-i-Punjab throughout the development period. The sucrose content showed a sharp increase from 50 days to 120 days after full bloom, then decreased slightly while, after stone hardening ended, other solids showed a gradual decreasing trend from 80 days after full bloom [7]. Genard *et al*. [9] studied the influence of assimilate supply, metabolism and dilution on sugar concentrations in the mesocarp of peach fruit during main stage of fruit enlargement. They observed that sucrose was highly sensitive to the changes in assimilate supply and to the dilution effect; it was not subject to intense metabolic transformation. The reducing sugars constituted a transitory storage pool and their concentrations were closely related to the metabolism.

Fig. 2. Seasonal Changes in Fruit Chemical Parameters of Nectarine cv. Silver King

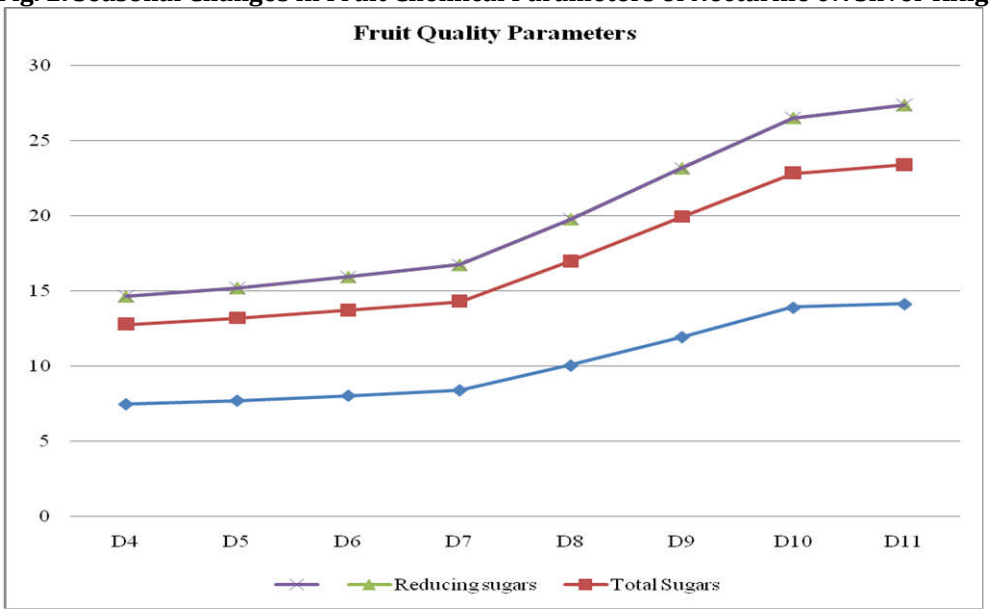
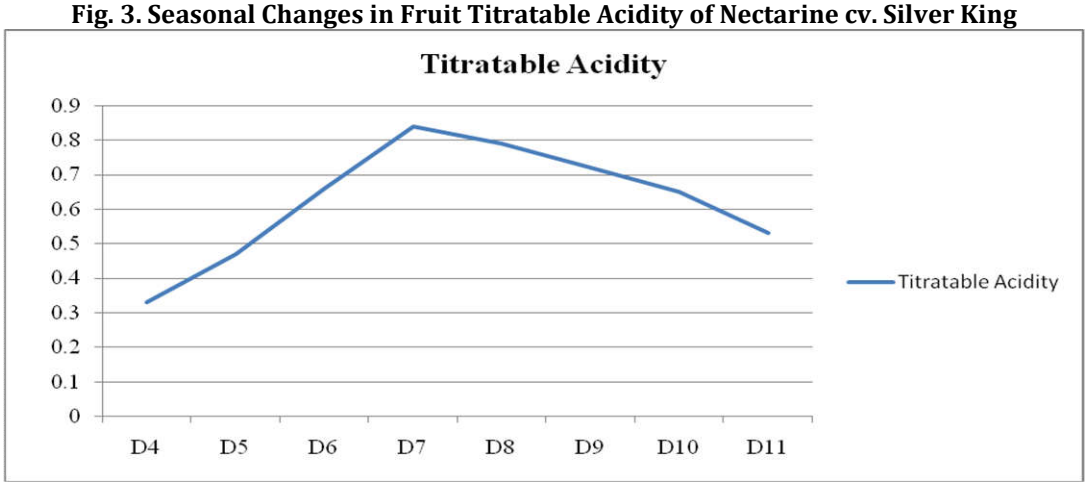


Fig. 3. Seasonal Changes in Fruit Titratable Acidity of Nectarine cv. Silver King



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