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PHENOLOGICAL BEHAVIOUR AND EFFECT OF DIFFERENT CHEMICALS ON PRE-HARVEST FRUIT DROP OF SWEET ORANGE CV. 'SALUSTIANA'

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Abstract

The paper depicts the phenological behaviour of sweet orange cv. 'Salustiana' and to search out the solution of a serious problem of pre harvest fruit drop. Citrus plants having uniform age and size were selected and shoots were tagged on four sides of the tree. Observations including blooming time, ratio of staminate and pistillate flowers, fruit growth and fruit drop were recorded. Maximum flower drop was observed in west and north side of the canopy, while maximum fruit set was on the east and north side. June drop was highest in the southern and northern sides. To address the problem of pre harvest drop of fruit, foliar sprays of urea (0.5%, 1.0% and 1.5%) and GA_3 (50 ppm, 75 ppm and 100 ppm) separately as well as in combinations were applied during mid of July and August. Percentage of fruit drop was reduced to the lowest values (1.70 and 2.28) after the first application of GA3 @ 100 ppm, and second application of GA3 @ 50 ppm respectively. Hence GA3 can effectively be used to control fruit drop in sweet orange cv. Salustiana.

Introduction

Citrus is an economically important crop of Pakistan, for its highly nutritive and commercial value. Phenology is one of the important aspects of citrus that needs to be studied. The information about phenological events and their variability can provide valuable data for planning, organizing and timely execution of certain standard management and cultural activities that require advanced information on the dates of specific stages of crop development.

There are some problems associated with production of citrus. It bears a large number of flowers but they drop at early stages of development. Bloom and fruit drops at fruit setting, natural June drop and eventually fruit drop before attaining the commercial ripening is a common phenomenon. Citrus species usually produce a large number of flowers during the flowering season. The floral load depends on the cultivar, tree age and environmental conditions (Monselise & Goren, 1978). Sweet Oranges produce around 50,000 flowers per tree in blooming season, although 95% to more than 99% flowers drop and only a small amount of these flowers become mature fruit (Chaudhary, 2006).

Besides flower drop in citrus, there are natural fruit drops like initial drop and June drop which can be attributed to many causes, both physical and pathological. Sudden changes in temperature or humidity, poor nutrition management, hormonal imbalance, improper soil moisture etc, are the physiological causes and the fungal infections lead to pathological fruit drop because fruit drop is also caused by damages due to diseases and pests (Racskó *et al*., 2007).

The drop of ripe fruit is of great significance in commercial cultivars. Application of plant growth regulators can control the hormone balance at the abscission layer, reducing

or retarding the early fruit fall and harvest losses (Modise *et al*., 2009). The application of auxin prevents the fruit from falling by preventing the synthesis of hydrolytic enzymes, such as cellulase (Monselise & Goren, 1978). Hormones usually act on the activity of polygalacturonase, in co-relation with cellulose, are responsible for degrading the main components of the cell wall, cellulose and pectin.

Many remedial measures have been adapted to reduce fruit drop in citrus right from cultural to nutritional and growth regulator treatments. The application of plant growth regulators can be helpful in maintaining hormone balance in the peel, as a result reducing the pre harvest drop and the losses at harvest. The application of 2,4-D and GA_3 reduces pre-harvest fall which retards abscission, rind softening, senescence and inhibits chlorophyll degradation (El-Otmani, 1992). Urea, KNO3 and NAA sprays significantly increases fruit retention and fruit yield (Sharma *et al*., 1990). This work was carried out to observe the phenological behaviour of sweet orange cv. 'Salustiana' and to search out the solution of preharvest fruit drop using different chemicals.

Materials and Methods

The trial was carried out in the Citrus Orchard of Horticultural Research Institute (HRI) at National Agriculture Research Centre (NARC) Islamabad. Full bearing Sweet Orange (*Citrus sinensis* L. Obesk) cv. 'Salustiana' plants, having uniform age and sizes were selected and tagged. Tagging of branches on four sides of the selected plants was done at random.

Phenological observations including flowering time (5% flowering), date of full bloom (70% flowering), sex expression, flower drop (%), fruit set (%) and fruit drop (%) with reference to orientation were taken. Following foliar treatments were also applied during mid August and mid September, and their effect on fruit drop was recorded.

Treatments

Treatments	Chemicals	Concentration
T_1	Control	H_2O spray
T_2	Urea	0.5%
T_3	Urea	1.0%
T_4	Urea	1.5%
T_5	GA_3	50 ppm
T_6	GA_3	75 ppm
T_7	GA_3	100 ppm
T_8	Urea + GA_3	0.5% + 50 ppm
T_9	Urea + GA_3	1.0% + 75 ppm
T_{10}	Urea + GA_3	1.5% + 100 ppm

Statistical analysis: The experiment was conducted through employing the Randomized Complete Block Design (RCBD) by using ten treatments, each comprising of three replications. Statistical analysis of the data was carried out by using Analysis of Variance (ANOVA) technique and differences among treatment means was compared by using Least Significance Difference (LSD) test at 5 % level of probability (Steel *et al.*, 1997).

Results and Discussion

Flowering: The data of flowering was recorded just after the formation of buds. Then the date for 5 % bloom and full bloom (70 %) was noted. Flowering (5 % blooming) started in the 2nd week of March and trees were in full bloom (70 %) until 25th March as shown in Table 1. Flowering starts with the spring flush of leaves mostly in March. In subtropical regions, in citrus major bloom usually occurs during the spring flush along with the vegetative sprouting. Under these environmental conditions, flowering takes place after a period of bud quiescence exposure to the low temperature and short days of winter. Generally, summer and fall flushes are less intense and produce almost exclusively vegetative shoots.

Shoot flushes: The trees were observed for date of emergence of each flush and total number of flushes. The data presented in Table 2 showed that 1st flush was observed in 1st week of March while the 2nd flush was observed in 2nd week of July and third additional flush in 2nd week of September.

Ratio of staminate and complete flower: The ratio between staminate and complete flowers was observed by taking a sample of 5 flowers from 5 plants in each replication. About less than 10 % of the flowers were male and more than 90 % flowers were hermaphrodite. However, orientation of plant has significance effect on flower sex expression as presented in Table 3. Ali (1960) found that 78.8 % flower was perfect and 21.2 % staminate with no pistilate flower in “Dasehari”. Majumdar and Mukherjee (1961) observed the highest percentage of perfect flowers on northern side of the trees and the lowest on the east side in cv. “Hemsagar”. Flower type staminate or pistilate depends upon the cultivar and other physiological condition and environmental conditions like light, temperature and moisture.

Flower drop: Data regarding flower drop has been presented in the Table 3. There was more flower drop on West and North Side of the tree (82.4 and 82.2 %) respectively, while minimum flower drop was observed on East and South side (79.3 and 79.8 %). Plants of the North side appeared to have almost 60% lower photosynthetic activity than those on the East side of tree canopy (Vasilakakis, 1996) On north side, light intensity remains comparatively low, which results in low availability of photosynthates. Ultimately, the limbs become weak and there is improper growth and development. Moreover there are more incidences of speedy wind coming form north and north-west directions that cause flower drop.

Fruit set: Fruit set after two weeks of full bloom or after petal fall was counted to calculate fruit set percentage. Maximum numbers of fruit set percentage was observed in East and North side (20.67 % and 20.18 %) respectively. Orientation of plants has greater effect on fruit set %. Flowering has a direct relationship with fruit set and crop production. An early evaluation of the reproductive status of citrus trees may reveal changes in final crop production, which is economically important for growers and industry. When day temperature starts raising at noon, the eastern side of the canopy comes under shade, while northern side totally remains safe from the severe effect of high light intensity on fruit setting. This may be a reason of more fruit set in both these sides.

Table 1. Flowering time of sweet orange cv. "Salustiana".

Dates	Blooming %
17th March	5% open flowers
25th March	Full bloom (70% open flowers)

Table 2. Time of shoot flushes in sweet orange cv. "Salustiana".

Flush No.	Initiation date	Completion date
1st flush	1st week of March	Last week of April
2nd flush	2nd week of July	End of August
3rd flush	2nd week of September	Mid of November

Table 3. Effect of orientation of plants on reproductive behaviour in sweet orange cv. "Salustiana"

Sides	Complete flower (%)	Staminate flower (%)	Flower drop (%)	Fruit set %	Fruit drop (%)	June drop %
East	87.66c	12.34 a	79.3 b	20.67a	23.5 a	29.3 b
West	91.22b	8.78 b	82.4 a	17.58b	27.3 a	32.3 ab
South	90.00b	10.00 a	79.8 b	17.76b	28.1 a	33.8 a
North	94.00a	6.00 b	82.2 a	20.18a	27.4 a	33.3 a

Means not sharing different letters in the columns differ significantly at $p<0.005$

Table 4. Effect of different chemical treatments on fruit drop in sweet Orange cv. "Salustiana"

Treatments	Fruit drop after 1st application	Fruit drop after 2nd application
H_2O spray	4.50 ab	3.85 b
0.5% Urea	6.60 a	5.55 a
1.0% Urea	2.45 b	3.26 ab
1.5% Urea	5.09 ab	6.26 a
50 ppm GA_3	1.95 b	2.28 b
75 ppm GA_3	2.51 b	5.10 ab
100 ppm GA_3	1.70 b	2.86 b
0.5% Urea + 50 ppm GA_3	2.93 ab	5.66 ab
1.0% Urea + 75 ppm GA_3	3.43 ab	3.26 ab
1.5% Urea + 100 ppm GA_3	2.62 b	4.29 ab

Means not sharing different letters in the columns differ significantly at $p<0.005$

Fruit drop: The data regarding the fruit drop as affected by different orientations were collected and analyzed. It is clear from the data presented in Table 3 that orientation had non significant difference with reference to fruit drop.

June drop: Data presented in Table 3 shows that maximum June Drop was calculated in South and North (33.8 % and 33.3 % respectively) while minimum June drop was recorded in East side of the plant (29.3 %). Northern side is at the direct hit of hot speedy winds, while southern side receives the maximum light intensity during June. High light intensity combined with the dry weather is one of the factors of fruit drop. Citrus fruit abscission is dependent on environmental, nutritional and hormonal factors (Gillaspy *et al.*, 1993). Nutritional factors are limiting factors, whereas hormonal compounds are factors of the regulation of the abscission process (Gómez *et al.*, 2000).

Pre-harvest drop: It is clear from the data presented in Table 4 that over all maximum amount of fruit drop was calculated in fruits treated with 0.5 % Urea; as compared to

minimum fruit drop in 50 ppm GA_3 treated fruits. Plant growth regulators are recommended only on healthy citrus block (Stover, 2000). External application of GA_3 has been found to prevent fruit drop in mandarins (Tominaga, 1998) and sweet orange (Liao *et al.*, 2006). The mechanism of GA_3 for fruit retention remains uncertain, but likely opposes the action of other growth regulators. Its application has recently been shown to accelerate IAA metabolism in citrus (Liao *et al.*, 2006).

Conclusion

The application of Growth regulator (GA_3) in the orange fruit orchard can be helpful in controlling pre-harvest fruit drop, hence increasing yield and giving good returns to the growers.

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