

Effect of GA₃ and Sitofex (CPPU) Spraying on Yield and Fruit Quality of "Kelsey" Plum Trees (*Prunus salicina* Lindl.)

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Abstract

A field experiment was conducted during 2018 and 2019 seasons at Abu El-Matamir region, El-Bohaira governorate, Egypt, to study the effect of foliar application of GA₃ and sitofex (CPPU) on yield and fruit quality of eight year "Kelsey" plum trees (*Prunus salicina* Lindl.). Foliar spray of sitofex (CPPU) at 0, 5, 10 and 15 ppm and GA₃ at 0, 20 and 40 ppm individually or in combination were done twice at full bloom and two weeks other. Twelve treatments were arranged in a randomized complete block design as split plot, gibberellic acid was assigned in the main plots while sitofex (CPPU) was assigned in sub plots. The results showed that, trees sprayed with GA₃ at 40 ppm + CPPU at 15 ppm or GA₃ at 20 ppm + CPPU at 15 ppm significantly increased fruit set %, yield (kg/ tree or ton/feddan) and some fruit physical parameters such as (fruit weight, fruit size and fruit juice). Fruit drop % was decreased compared to control and other treatments. Chemical fruit quality such as SSC %, total acidity and SSC/acid ratio were also improved as compared to control. It could be recommended that, "Kelsey" plum trees sprayed with GA₃ at 40 ppm + CPPU at 15 ppm or GA₃ at 20 ppm + CPPU at 15 ppm twice at the full bloom and after two weeks from full bloom which are considered the best combination treatments used to increasing the percentage of fruit size, yield and fruit weight as well as improving the other characteristics of fruit quality.

Key words: *Prunus salicina*, sitofex, CPPU, GA₃, fruit quality.

Introduction

"Kelsey" plum (*Prunus salicina* Lindl.) is grown successfully under Egyptian conditions since 1980; due to its low chilling requirements, adapts to the warm climate and increasing demands of local consumption, fruits ripen in late July with high yield (Hamza *et al.*, 2014). Moreover, plums fruit have high nutritive value in terms of carbohydrates, low in fats and calories, excellent source of vitamins A and C, calcium, magnesium, iron, potassium and fibers (Lozano *et al.*, 2009). Despite its attributes and commercial importance, "Kelsey" plum is still requiring an attention from researchers for further studies to improve productivity and the quality of the fruits. In this respect, fruit size is an important component for plum fruit quality and marketing. Foliar application of bio-regulators like gibberellic acid (GA₃) and synthetic cytokinin such as sitofex (CPPU) are the best practice for bearing large fruit size and improving other characteristics of fruit quality of plum. Forchlorofenuronis (CPPU) or sitofex a member of the synthetic cytokinin group with phenyl urea structure (Arima *et al.*, 1995). CPPU or N - (2 - Chloro - 4 - pyridyl) - N - phenylurea) have successfully improved fruit size in different fruit crops (Guirguis *et al.*, 2010, Banyal *et al.*, 2013, Fathi *et al.*, 2013 and Hota *et al.*, 2017). The enhancement effect of CPPU on fruit size is due to stimulating cell division in the early stage and promoting cell enlargement in the late stage of fruit development (El Salhy *et al.*, 2009 and Hajam *et al.*, 2018). Moreover, CPPU applications recorded

numerous advantages as lick leading fruits more firmly and to more round or oval shape (El Abbasy *et al.*, 2015). Similarly, gibberellins constitute a group of plant hormones that control developmental processes such as germination, shoot elongation, flowering, fruit set, yield and fruit quality (Yamamura *et al.*, 1989; Yehia and Hassan 2005; Kassem *et al.*, 2010; Abd El Baree *et al.*, 2013; Nabil *et al.*, 2013 and Mosa *et al.*, 2015). The main effect of this growth regulator on fruits is enhancing cell elongation and cell enlargement witch increase the fruit length and size (Zoffoli *et al.*, 2009). Therefore, the exogenous applications of CPPU and GA₃ aimed to ensure economical yield with a good quality for "Kelsey" plum trees. In this respect, Fathi *et al.*, (2011) reported that foliar sprays of 5 and 10 ppm CPPU alone or in combination with 0., 10 and 20 ppm GA₃ at full bloom or fruit set, significantly increased vegetative growth, leaf chlorophyll, yield and fruit quality parameters namely length, diameter, weight, size, firmness, T.S.S. and acidity of "Costata" persimmon. Also, Hifny *et al.*, (2017) revealed that foliar application of Washington Navel orange with CPPU at 4 ppm + GA₃ at 30 ppm at full bloom significantly increased fruit set %, retained fruits % and yield, moreover enhanced fruit physical parameters such as fruit weight, size, length, diameter and fruit juice volume, while the fruit drop percentage was decreased in comparison with untreated trees. Also, it improved fruit biochemical characteristics such as TSS %, total acidity, TSS/acid ratio and vitamin C. In this line, Khot *et al.*, (2015) summarized that, foliar application of CPPU at 2

ppm + GA₃ at 40 ppm at full bloom stage increased bunch weight and total yield of Thompson seedless grape and also increased berry physical quality parameters namely berry length and diameter as well as juice T.S.S.

Therefore, this investigation was conducted to study the effect of exogenous application of sitofex (CPPU) and GA₃ individually or in combinations to improving yield and fruit quality of "Kelsey" plum trees.

Materials and methods

The present study was carried out in a private orchard at Abu El-Matamir region, El-Bohaira governorate, Egypt, during 2018 and 2019 seasons in order to study the effect of sitofex (CPPU) and gibberellic acid (GA₃) alone or in combinations on yield and fruit quality of "Kelsey" plum trees. In this trial, eight years old "Kelsey" plum (*Prunus salicina* Lindl.) trees budded on Mariana rootstock, and planted at 4 × 5 meter apart in calcareous soil under drip irrigation system. The soil texture was sandy (7.73% clay, 15.19% silt and 77.08% sand), 1.38 dSm⁻¹ an electrical conductivity and pH of 8.15. Thirty six trees uniform in growth, vigour and productivity were selected, and subjected to the same cultural practices commonly adopted on the orchard. The chosen trees were arranged in a randomized complete block design as split plot, each treatment replicated three times with one tree for each replicate. Main plots were randomly assigned for gibberellic acid (GA₃) as foliar application at 0, 20 and 40 ppm. Sub plots were randomly assigned for sitofex (CPPU) as foliar sprays at 0, 5, 10 and 15 ppm. So, this experiment included twelve treatments resulting from the two factors (3 concentrations of GA₃ × 4 concentrations of CPPU).

CPPU (N-(2-chloro-4-pyridinyl)-N-phenylurea) solution was prepared from sitofex compound (0.01% CPPU) as source of CPPU, while gibberellic acid was used as sodium salt of gibberellic acid (Berlex); each tree was sprayed twice at full bloom and two weeks after from full bloom with 10 L/tree of the solution at early morning. Four branches per each tree distributed in four directions were tagged for measuring and determination the following parameters:

1. Fruit set and fruit drop %:

Number of flowers, fruitlets at initial set (15 days after full bloom) and the fruits at harvest time were counted on the selected main branches for calculated fruit set and fruit drop percent by the following equations: Fruit set % =

$$\frac{\text{No. of harvested fruits}}{\text{No. of flowers}} \times 100$$

Fruit drop %

$$= \frac{\text{No. of fruitlets at initial set} - \text{No. of harvested fruits}}{\text{No. of fruitlets at initial set}} \times 100$$

2. Yield:

Yield was harvested at July 26th and 29th in 2018 and 2019, respectively. Yield of each replicate was determined as kg/tree and ton/feddan. Yield per tree was divided up according to their fruit diameter to three categories, large > 5.0 cm, medium 5.0 – 4.5 cm and small < 4.5 cm.

3. Fruit quality:

Twenty fruits were randomly sampled from each replicate to determine fruit quality as fruit weight (g), fruit size (cm³) and juice %. Also, soluble solids content was determined by using hand refractometer, total acidity as malic acid were determined according to (A.O.A.C., 1990) and SSC/acid ratio was estimated.

4. Statistical analysis:

The obtained data were subjected to analysis of variance according to **Snedecor and Cochran (1990)**. The differences among treatment means were compared with Duncan multiple range tests (DMRT) at 5% level according to **Duncan (1955)**.

Results and discussion

1. Fruit set %:

The results in Table (1) showed significant differences among different concentrations of GA₃, CPPU and their interactions on fruit set % of Kelsey plum trees in both seasons. Spraying GA₃ increased significantly fruit set % as compared to control in both seasons. With regarding GA₃ concentrations, data showed that, spraying gibberellic acid at 40 ppm gave the highest percentage fruit set during both seasons. Similar results were obtained by **Abd El Baree et al., (2013)** and **Mosa et al., (2015)**. In this respect, **Nabil et al., (2013)** revealed that spraying GA₃ at 25 and 50 ppm twice at full bloom and after two weeks on Hollywood and Golden Japanese plum increased fruit set (%) in both cultivars especially at 50 ppm concentration.

Regarding the effect of spraying CPPU on fruit set %, data in Table (1) cleared that, CPPU had significantly positive effect on fruit set % than control in both seasons. Application of CPPU at 15 ppm recorded the highest significant values of fruit set followed in a descending order by spraying with 10 and 5 ppm, whereas, the lowest values were obtained from control in both seasons. The results are in harmony with the findings of **Guirguis et al., (2010)** and **Hota et al., (2017)**. Also, **Assad (2013)** reported that, spraying CPPU at 5 or 10 ppm after one week of full bloom recorded the highest values of fruit set of Hollywood and Santarosa Japanese plum.

The highest fruit set % was recorded by spraying GA₃ at 40 ppm combined with CPPU at 15 ppm followed in a descending order by GA₃ at 20 ppm + CPPU at 15 ppm and GA₃ at 40 ppm + CPPU at 10 ppm without significant difference among them in

both seasons. On the other hand, control treatment gave the lowest values of fruit set % in both seasons. The increase in fruit set as a result of different concentrations of CPPU and GA₃ might be due to its effect on retarding abscission, enhancing resistance to water and nutrient stress and enhanced photosynthesis and mobilization of metabolites to the flowers. This result was supported by **Sasaki and Utsunomiya (2002)** and **Susila et al., (2013)**. In this line, **Khot et al., (2015)** revealed that foliar spray with 40 ppm GA₃ + 2 ppm CPPU increased fruit set % of grapevines. Also, **Fathi et al., (2011)** revealed that, sprays GA₃ at 10 ppm combined with CPPU at 5 or 10 ppm was responsible for maximizing fruit set % of Costata persimmon trees.

2. Fruit drop %:

Results presented in Table (1) indicate that the percentage of fruit drop was significantly affected by all treatments of GA₃, CPPU and their interactions on Kelsey plum trees in both seasons. Spraying trees twice at full bloom and after two weeks with GA₃ led to significantly decreased fruit drop %, especially at concentration of 40 ppm in both seasons. On the other hand, the highest percentage of fruit drop was

observed on control trees. These results are in accordance with those obtained by **Kassem et al., (2010)** and **Mosa et al., (2015)**. In this line, **Yamamura et al., (1989)** found that the application of GA₃ at 25 and 50 ppm significantly reduced fruit drop in Saijo and Fuyu cultivars of persimmon.

As for the effect of CPPU application, it is clear that spraying the trees with CPPU significantly decreased the fruit drop compared to control in both seasons. This decrease was proportional to the concentrations of CPPU. On the other words, the lowest value of this parameter was found in trees sprayed with CPPU at 15 ppm followed by 10 and 5 ppm in both seasons, respectively. On the contrary, the highest percentage of fruit drop was always concomitant to unsprayed trees (control) during 2018 and 2019 seasons. These results are in agreement with the findings of **Ahmed and Abd El Aal (2007)** and **Guirguis et al., (2010)**. In this respect, **Assad (2013)** revealed that, spraying of CPPU at 5 or 10 ppm after one week from full bloom recorded the lowest values of fruit drop for Hollywood and Santarosa plum trees.

Table 1. Effect of GA₃, sitofex (CPPU) and their interactions on fruit set and fruit drop (%) of Kelsey plum trees in 2018 and 2019 seasons

GA ₃ concentrations (ppm)	Sitofex concentrations (ppm)				Mean (A)	Sitofex concentrations (ppm)				Mean (A)
	0	5	10	15		0	5	10	15	
Fruit set (%)										
Season, 2018					Season, 2019					
0	8.38f	16.48b	14.87c	13.63d	13.34C	9.74g	16.88d	14.81e	14.22e	13.91C
20	12.48e	15.61bc	15.98b	20.23a	16.07B	13.18f	18.16c	18.28c	22.41a	18.00B
40	13.23de	15.77bc	19.80a	20.67a	17.36A	14.28e	19.54c	20.87b	22.55a	19.31A
Mean (B)	11.36D	15.95C	16.88B	18.17A		12.40D	18.19B	17.98C	19.72A	
Fruit drop (%)										
Season, 2018					Season, 2019					
0	62.18a	61.18a	61.14a	60.91ab	61.35A	60.24a	58.42b	57.63c	57.30cd	58.39A
20	61.70a	58.67bc	57.17cd	54.97e	58.12B	58.51b	55.20e	54.21g	53.48h	55.36B
40	60.73ab	57.59cd	56.00de	54.59e	57.22C	57.15d	54.61f	54.36fg	52.74i	54.71C
Mean (B)	61.53A	59.14B	58.10BC	56.82C		58.63A	56.07B	55.40C	54.50D	

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Regarding to the interaction, data presented in Table (1) showed that, fruit drop % was significantly decreased by using all tested treatments on Kelsey plum trees compared to control in both seasons. Moreover, the minimum percentage of fruit drop was recorded with the combination treatment GA₃ at 40 ppm + CPPU at 15 ppm followed by GA₃ at 20 ppm + CPPU at 15 ppm and GA₃ at 40 ppm + CPPU at 5 ppm as compared with control in both seasons. Similar results were obtained by **Sasaki and Utsunomiya (2002)** and **Hifny et al., (2017)** they reported that, spraying GA₃ and CPPU alone or combined together significantly decreased the percentage of fruit drop on mango and orange trees.

It is obvious from data in Table (1) that, fruit set and fruit drop % of Kelsey plum trees were

significantly enhanced by spraying with GA₃ and CPPU alone or combined as compared with unsprayed trees in both seasons. Moreover, spraying with GA₃ at 40 ppm + CPPU at 15 ppm or GA₃ at 20 ppm + CPPU at 15 ppm appeared to be superior in improving fruit set and reducing fruit drop as compared with control. The obtained results are in line with the previously reported by **Sasaki and Utsunomiya (2002)**, **Guirguis et al., (2010)**, **Assad (2013)**, **Nabil et al., (2013)**, **Khot et al., (2015)** and **Mosa et al., (2015)**. They all stated the positive influence of GA₃ and/or CPPU on fruit set and fruit drop of different fruit crops.

3. Yield:

The results in Table (2) showed that, spraying GA₃ and CPPU alone or combined together

significantly increased fruit yield of Kelsey plum expressed as kg/tree and ton/feddan in both seasons. As for the effect of gibberellic acid, it was evident that gibberellic acid significantly increased the yield as compared with control. Fruit yield as kg/tree and ton/feddan were significantly increased when GA₃ concentration increased especially at 40 ppm as compared to control in both seasons. The obtained results are in line with the findings of **Yehia and Hassan (2005)**, **Abd El Baree et al., (2013)** and **Mosa et al., (2015)**. In this respect, **Nabil et al., (2013)** stated that, the using of GA₃ at 25 and 50 ppm twice at full bloom and after two weeks on Hollywood and Golden plum trees increased yield of both cultivars especially at 50 ppm.

The yield was gradually and significantly increased by increasing the concentration of CPPU in both seasons (Table 2). Spraying CPPU at 15 ppm tended to give the highest values of yield as kg/tree and ton/feddan followed by 10 and 5 ppm in both seasons, respectively. On the contrary, unsprayed trees (control) produced the lowest values of fruit yield in both seasons. These results are in agreement with those obtained by **Ahmed and Abd El Aal (2007)** and **Banyal et al., (2013)**, reported that, application of sitofex at 5, 10 and 15 ppm increased the yield of Le Conte pear and apple trees. Also, **Guirguis et al., (2010)** and **Assad (2013)** revealed that, persimmon and plum trees sprayed with CPPU at 10 ppm produced higher yield (kg/tree) than unsprayed trees.

Table 2. Effect of GA₃, sitofex (CPPU) and their interactions on yield of Kelsey plum trees in 2018 and 2019 seasons

GA ₃ concentrations (ppm)	Sitofex concentrations (ppm)				Mean (A)	Sitofex concentrations (ppm)				Mean (A)
	0	5	10	15		0	5	10	15	
Yield (kg/tree)										
Season, 2018					Season, 2019					
0	18.17h	22.57f	25.67e	25.72e	23.03C	16.18k	20.34i	24.32g	24.48g	21.33C
20	20.70g	27.48d	30.50b	34.83a	28.37B	19.37j	26.24f	29.76d	35.16b	27.63B
40	22.77f	28.97c	34.90a	35.39a	30.50A	21.46h	28.22e	34.79c	35.48a	29.98A
Mean (B)	20.54D	26.34C	30.35B	31.98A		19.00D	24.93C	29.62B	31.70A	
Total yield (ton/feddan)										
Season, 2018					Season, 2019					
0	3.81h	4.73f	5.39 e	5.40 e	4.83 C	3.39j	4.27h	5.10f	5.14f	4.47 C
20	4.34g	5.77d	6.40 b	7.31 a	5.95 B	4.06i	5.51e	6.24c	7.38ab	5.80 B
40	4.78f	6.08c	7.32 a	7.43 a	6.40 A	4.50g	5.92d	7.30b	7.45a	6.29 A
Mean (B)	4.31D	5.52 C	6.37 B	6.71A		3.99 D	5.23 C	6.22 B	6.65 A	

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Regarding the interaction, all treatments significantly increased the yield as compared to control. Moreover, trees sprayed with GA₃ at 40 ppm + CPPU at 15 ppm gave better fruit yield than the other treatments followed by trees treated by GA₃ at 20 ppm + CPPU at 15 ppm and GA₃ at 40 ppm + CPPU at 10 ppm in both seasons. Otherwise, the control trees gave the lowest yield during the two seasons of the study. The increasing in tree yield might be due to GA₃ and CPPU influenced the increase on fruit set, reduce fruit drop (Table 1), positive effect on growth and development of fruits resulted into increase the percentage of large size fruits reached to the stage of harvest (Table 3). Also, an increase in fruit weight and size (Table 4) resulted from accumulation of dry matter in the fruits, rapid cell division and elongation and consequently increased the yield. Similarly, higher yield was obtained by **Marvet et al., (2001)** on Thompson Seedless' grapevines, following the application of sitofex (CPPU) when applied at 3, 5, 7 ppm alone or in mixture with GA₃ at 40 ppm. Moreover, **Stern et al., (2006)** stated that, the improving effect of Sitofex on fruit weight and dimensions, as well as on

reducing pre-harvest fruit drop resulted in increased fruit yield in apple trees. These findings related to higher yield with CPPU are in agreement with those obtained by **Ahmed and Abd El Aal (2007)** in pear trees, **Fathi et al., (2011)** in persimmon trees and **Abd El Raheem et al., (2013)** and **Hifny et al., (2017)** in 'Washington Navel' orange trees.

4. Fruit size distribution:

Results presented in Table (3) show the effect of GA₃, CPPU and their combinations on fruit size distribution of Kelsey plum fruits. In general, it is clear from Table (3) that, application of gibberellic acid and sitofex produced the larger fruits by 49.28% followed by medium fruits with 32.60 percent compared to 18.12% small fruit. Spraying the different concentrations of GA₃ and CPPU as individual application led to significantly decreased small and medium fruits as compared with control, whereas there is no significant variation among concentrations of gibberellic acid and CPPU in the same category. In large fruit category, spraying with GA₃ and CPPU significantly increased the large fruit compared to control. This increase is proportional to increase the concentrations of GA₃ and CPPU.

Anyhow, gibberellic acid significantly increased large and medium fruit percent compared to small fruit, whereas there is no significant variation between the two concentrations of gibberellic acid in the same category. Also, Kelsey plum trees sprayed with GA₃ at 20 or 40 ppm produce high yield with large fruit size since, the percent reached about 52% of large fruits.

As for the effect of sitofex (CPPU), the results in Table (3) showed that, application of CPPU at the full bloom and after two weeks was significantly

increased the large fruits compared to medium and small fruits. In large fruit category, spraying CPPU at 15 ppm significantly increased the large fruit followed by 10 and 5 ppm compared to control treatment, respectively. On the other hand, all concentrations of CPPU produce lower medium and small fruits as compared to control treatment, but there is no significant variation among CPPU concentrations on this variable under categories of the medium and small fruits.

Table 3. Effect of GA₃, sitofex (CPPU) and their interactions on fruit size distribution % according to diameter of Kelsey plum fruits

GA ₃ concentrations (ppm)	Sitofex concentrations (ppm)				Mean (A)
	0	5	10	15	
Small fruits (%)					
0	29.82 a	19.61 d	18.13 e	17.74 ef	21.32 A
20	22.65 b	16.97 fg	14.36 h	13.38 hi	16.84 B
40	21.34 c	16.08 g	14.08 hi	13.31 i	16.20 B
Mean (B)	24.60 A	17.55 B	15.52 C	14.81 C	18.12
Medium fruits (%)					
0	43.35 a	31.82 b	31.21 b	31.47 b	34.46 A
20	30.19 b	31.59 b	32.20 b	32.47 b	31.61 B
40	30.39 b	31.79 b	32.30 b	32.47 b	31.73 B
Mean (B)	34.64 A	31.73 B	31.90 B	32.13 B	32.60
Large fruits (%)					
0	26.82 f	48.49 de	50.65 cd	50.78 bcd	44.18 B
20	47.15 e	51.43 abc	53.43 abc	54.15 a	51.54 A
40	48.26 de	52.12 abc	53.61 ab	54.25 a	52.06 A
Mean (B)	40.74 D	50.68 C	52.56 B	53.06 A	49.28

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Regarding the interaction, the obtained data showed that, trees sprayed with all combination among GA₃ and CPPU concentrations produced higher category of large fruits than control and other treatments. Similar results were obtained by **Curry and Greene (1993)** and **Flaishman et al., (2001)** on apple and pear trees. In this respect, **Stern et al., (2003)** they found that, applying CPPU at 10 ppm after two weeks of full bloom have a significant potential to improve yield and fruit size of 'Royal Gala' apple.

5. Fruit quality:

5.1. Physical characters:

Data presented in Table (4) cleared that, the highest values of fruit weight (g), fruit size (cm³) and fruit juice (%) were obtained from spraying GA₃ at 40 ppm followed by 20 ppm as compared to control. The differences were significant among GA₃ concentrations in both seasons. These results agree with those obtained by **Yamamura et al., (1989)** and **Abd El Barea et al., (2013)** on persimmon trees. Also, **Yehia and Hassan (2005)** revealed that the highest fruit weight and fruit volume produced from Le Conte pear trees as a result of sprayed 20 and 40

ppm GA₃ at full bloom and three weeks after full bloom. In this line, **Hifny et al., (2017)** cleared that spraying Washington Navel orange trees by GA₃ at 20 or 30 ppm significantly increased fruit physical parameters such as fruit weight (g), fruit size (cm³) fruit length, fruit diameter (cm) and fruit juice (cm³) in comparison to unsprayed trees.

With regard to the effect of CPPU, the results in Table (4) revealed that fruit weight, size and juice % were gradually increased by increasing the concentration of CPPU from 0 to 15 ppm with significant differences among them in both seasons. Similar results were reported by **El Sabagh (2002)** and **Guirguis et al., (2010)**. The increase in fruit weight and size may be due to application of CPPU that plays an important role in enhancing both cell division and elongation as well great role in activating the biosynthesis of proteins, RNA and DNA (**Curry and Greene 1993**). In this respect, **Assad (2013)** concluded that spraying of CPPU at 5 or 10 ppm after one week of full bloom recorded the highest values of physical fruit quality characters such as fruit weight, size, length, diameter and firmness of Hollywood and Santarosa plum trees.

Table 4. Effect of GA₃, sitofex (CPPU) and their interactions on physical quality of Kelsey plum fruits in 2018 and 2019 seasons

GA ₃ concentrations (ppm)	Sitofex concentrations (ppm)				Mean (A)	Sitofex concentrations (ppm)				Mean (A)
	0	5	10	15		0	5	10	15	
Fruit weight (g)										
Season, 2018					Season, 2019					
0	83.51l	85.27k	87.00h	88.48f	86.06C	84.35j	87.84g	91.62e	92.15d	88.99C
20	85.54j	87.76g	92.20d	95.48b	90.24B	86.51i	89.18f	94.39c	99.18a	92.31B
40	86.54i	90.54e	95.04c	96.13a	92.06A	87.63h	91.61e	97.97b	99.23a	94.11A
Mean (B)	85.19D	87.85C	91.41B	93.36A		86.16D	89.54C	94.66B	96.85A	
Fruit size (cm³)										
Season, 2018					Season, 2019					
0	81.5l	87.5h	86.7i	88.2g	86.0C	83.3l	94.2i	101.7g	102.1f	95.3C
20	85.5k	88.7f	95.7d	104.0b	93.5B	89.6k	97.6h	104.4d	116.6b	102.1B
40	86.5j	93.6e	103.8c	104.5a	97.1A	90.8j	104.3e	116.0c	117.1a	107.1A
Mean (B)	84.5D	89.9C	95.4B	98.9A		87.9D	98.7C	107.4B	111.9A	
Fruit juice %										
Season, 2018					Season, 2019					
0	29.20i	29.81h	30.42g	30.94e	30.09C	30.65i	31.92g	33.30e	33.49d	32.34C
20	29.91h	30.69f	32.23c	33.38b	31.55B	31.44h	32.41f	34.30c	36.00a	33.53B
40	30.26g	31.66d	33.23b	33.61a	32.19A	31.85g	33.29e	35.60b	36.06a	34.20A
Mean (B)	29.79D	30.72C	31.96B	32.64A		31.31D	32.54C	34.40B	35.18A	

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

The interaction effect between spraying GA₃ and CPPU concentrations was significant in both seasons. Data in Table (4) indicated that spraying Kelsey plum trees with combination of CPPU and GA₃ improved the fruit physical characteristics such as fruit weight (g), fruit size (cm³) and juice % in the two studied seasons. The highest values of fruit weight, size and juice % were obtained by using GA₃ at 40 ppm + CPPU at 15 ppm followed by GA₃ at 20 ppm + CPPU at 15 ppm and GA₃ at 40 ppm + CPPU at 10 ppm in both seasons, respectively. These results are in harmony with those reported by *Yahata et al., (2006)*, *Fathi et al., (2011)* and *Abd El Raheem et al., (2013)* on different fruit crops. Also, *Hifny et al., (2017)* reported that spraying Washington Navel orange trees with GA₃ at 30 ppm + CPPU at 4 ppm at full bloom gave the highest values of yield (kg) /tree and fruit physical properties in terms of fruit weight (g), fruit size (cm³) fruit length, fruit diameter (cm) and fruit juice (cm³) compared to unsprayed trees.

5.2. Chemical characters:

The results in Table (5) indicated that, spraying GA₃ at 20 and 40 ppm caused a significantly increased in soluble solids content (SSC %), SSC/acid ratio and decreased total acidity as compared with control. This effect was more pronounced with the using of GA₃ at 40 ppm. These results are in agreement with those obtained by *Yehia and Hassan (2005)*, *Nabil et al., (2013)* and *Hajam et al., (2018)*.

As for the effect of CPPU, the results in Table 5 revealed that SSC% was significantly decreased with increasing CPPU concentration, while total acidity was slightly increased without significant

differences in most cases with increasing sitofex concentration in both seasons. In this respect, the lowest values of SSC/acid ratio were recorded on trees sprayed with CPPU at 5 ppm followed in an ascending order by spraying with CPPU at 10 and 15 ppm, while, the highest values were obtained from control in both seasons. These results are agreed with *Ahmed and Abd El Aal (2007)* on Le Conte pear, *El Sabagh (2002)* on apple, *Guirguis et al., (2010)* on persimmon and *Assad (2013)* on Hollywood and Santarosa plum trees.

In regarding to the interaction, data presented in Table 5 showed that SSC%, total acidity and SSC/acid ratio were significantly affected by using all tested treatments on Kelsey plum trees compared to control in both seasons. Moreover, the minimum percent of SSC and SSC/acid ratio were recorded with CPPU at 15 ppm followed in an ascending order by CPPU at 10 ppm and CPPU at 5 ppm as compared with control in both seasons. On contrary that, the maximum acidity was recorded by CPPU at 15 ppm followed in a descending order by CPPU at 10 and 5 ppm as compared with control in both seasons. So, it is obvious from above results that sitofex and GA₃ expresses promoted variation effects between treatments; this means that, the use of CPPU either singly or in combination with GA₃ delayed fruit maturity. These finding confirmed the former results obtained by *Sasaki and Utsunomiya (2002)*, *Guirguis et al., (2010)*, *Fathi et al., (2011)*, *Abd El Raheem et al., (2013)* and *Hifny et al., (2017)* on different fruit crops, they found that, spraying sitofex (CPPU) and GA₃ delay fruit maturity compared with unsprayed trees.

Table 5. Effect of GA₃, sitofex (CPPU) and their interactions on chemical quality of Kelsey plum fruits in 2018 and 2019 seasons

GA ₃ concentrations (ppm)	Sitofex concentrations (ppm)				Mean (A)	Sitofex concentrations (ppm)				Mean (A)
	0	5	10	15		0	5	10	15	
SSC %										
Season, 2018					Season, 2019					
0	12.11c	11.58g	11.41h	11.15i	11.56C	12.09c	11.62h	11.46i	11.31j	11.62C
20	12.30b	11.87f	11.90ef	11.94de	12.02B	12.27b	11.80g	11.85f	11.90e	11.95B
40	12.45a	11.95de	11.95de	11.90ef	12.07A	12.50a	11.90e	11.93de	11.95d	12.07A
Mean (B)	12.28A	11.80B	11.76C	11.66D		12.28A	11.77B	11.74C	11.72C	
Acidity %										
Season, 2018					Season, 2019					
0	0.92ab	0.94ab	0.96a	0.97a	0.94A	0.94bc	0.97ab	0.98a	1.00a	0.97A
20	0.86cd	0.90bc	0.85cd	0.84d	0.86B	0.81f	0.93c	0.89d	0.84ef	0.86B
40	0.81d	0.86cd	0.85cd	0.82d	0.83B	0.77g	0.93c	0.87de	0.84ef	0.85B
Mean (B)	0.86B	0.90A	0.88AB	0.87B		0.84B	0.94A	0.91A	0.89AB	
SSC/acid ratio										
Season, 2018					Season, 2019					
0	13.16d	12.31e	11.88f	11.49f	12.21C	12.85f	11.97g	11.73g	11.31h	11.96C
20	14.30bc	13.18d	13.99c	14.21bc	13.92B	15.14b	12.68f	13.31e	14.16c	13.82B
40	15.36a	13.89c	14.09c	14.51b	14.46A	16.23a	12.79f	13.70d	14.22c	14.23A
Mean (B)	14.27A	13.13C	13.32B	13.40B		14.74A	12.48D	12.91C	13.23B	

Means followed by the same letter within a column are not significantly different using DMRT at P ≤ 0.05

Conclusions

It could be concluded that, spraying "Kelsey" plum trees with GA₃ and CPPU at different concentrations significantly increased fruit set, yield and gave the heaviest and largest fruits as well as reduced fruit drop compared to unsprayed trees. Also, spraying GA₃ and CPPU led to improve SSC (%), total acidity (%) and SSC/acid ratio in fruit juice. The best fruit characters and total yield were obtained with GA₃ at 40 ppm + CPPU at 15 ppm or GA₃ at 20 ppm + CPPU at 15 ppm applications.

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تأثير الرش بالجبرلين و السيتوفكس على المحصول و جودة ثمار أشجار البرقوق صنف كلزى .

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أجريت تجربة خلال موسمي 2018 و 2019 في مزرعة خاصة بأبو المطامير - محافظة البحيرة - مصر. لدراسة تأثير رش حمض الجبريليك و السيتوفكس على محصول وجودة ثمار أشجار البرقوق صنف كلزى عمر ثمانية سنوات. تم رش السيتوفكس بأربع تركيزات هم 0 و 5 و 10 و 15 جزء في المليون و حمض الجبريليك بثلاث تركيزات هم 0 و 20 و 40 جزء في المليون بمفردهم أو في عدة توليفات مرتين عند قمة التزهير وبعد أسبوعين من الإزهار الكامل على أشجار البرقوق صنف كلزى عمرها ثماني سنوات، مطعومة على أصل الماريانا، مزروعة على مسافات الزراعة 4 × 5 متر و تنمو في تربة جيرية تحت نظام الري بالتنقيط. تم توزيع إثني عشر معاملة في تصميم قطاعات كاملة العشوائية كتجربة منشقة، تم توزيع تركيزات حمض الجبريليك بشكل عشوائي في القطع الرئيسية و توزيع تركيزات السيتوفكس بشكل عشوائي في القطع المنشقة.

أظهرت النتائج: أن رش الأشجار بـ 40 جزء في المليون من حمض الجبريليك + السيتوفكس بتركيز 15 جزء في المليون أو 20 جزء في المليون من حمض الجبريليك + 15 جزء في المليون من السيتوفكس أدبا إلى زيادة معنوية في نسبة عقد الثمار و النسبة المئوية للثمار كبيرة الحجم و المحصول سواء كجم / شجرة أو طن / فدان، وكذلك الصفات الطبيعية للثمار مثل وزن و حجم الثمار و محتوى الثمار من العصير، بينما أعطيا أقل نسبة مئوية لتساقط الثمار و ذلك عند المقارنة مع باقى المعاملات. أيضا تأثرت صفات الثمار الكيمائية مثل نسبة المواد الصلبة الذاتية و الحموضة و نسبة المواد الصلبة الذاتية الى الحموضة بشكل إيجابي باستخدام هاتين المعاملتين و ذلك عند المقارنة مع معاملة الكنترول و المعاملات الأخرى.

و بناء على يمكن التوصية برش أشجار البرقوق صنف كلزى باستخدام 40 جزء في المليون من حمض الجبريليك + السيتوفكس بتركيز 15 جزء في المليون أو 20 جزء في المليون من حمض الجبريليك + 15 جزء في المليون من السيتوفكس مرتين عند قمة التزهير و بعد أسبوعين من الإزهار الكامل حيث أدبا إلى زيادة النسبة المئوية للثمار كبيرة الحجم التي وصلت إلى مرحلة الحصاد، مع أقصى محصول (كجم/شجرة و طن/فدان) وزيادة وزن و حجم الثمار وكذلك تحسين جودة الثمار.