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# RESPONSE OF SIDDEK AND KIETT MANGO TREES TO GIBBERELLIC ACID AND UREA FOLIAR SPRAYING AT FLOWER BUD INDUCTION PERIOD A. FLORAL ASPECTS

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**ABSTRACT:** During 2014/ 2015 and 2015/ 2016 seasons, a field experiment was conducted on 45 trees of each of Siddek and Kiett mango cvs. The trees were 8-year-old, grafted on Succari rootstock, similar in growth vigour as possible and grown at 4 × 3 m in sandy soil under drip irrigation system in a private mango orchard at Belbies District, Sharkia Governorate, Egypt. The experimental trees were foliar sprayed with $GA_3$ at 0, 50 or 100 ppm and urea at 1.5% either alone or in combination with $GA_3$ at 100 ppm. The trees were sprayed at 3 dates at fortnightly intervals (1st Dec., mid Dec. and 1st Jan.). The obtained results showed that sex ratio, fruit set and flower drop percentages were higher on Siddek trees than those of Kiett ones. The trees were sprayed at mid Dec. induced the highest sex ratio and fruit set percentages. The trees were sprayed at early Dec. showed the highest flower drop percentage than those sprayed at the other two dates. Fruit retention percentage was significantly affected by either variety or spraying date in both seasons. Mango trees sprayed with $GA_3$ at 100 ppm or urea at 1.5% either alone or combined exhibited the highest values of sex ratio, fruit set and fruit retention percentages in most cases. Whereas, unsprayed trees (control) and those sprayed with $GA_3$ at 50 ppm induced the highest flower drop percentage. It is quite evident from the previous trends that spraying Siddek and Kiett mango trees with $GA_3$ at 100 ppm or urea at 1.5% either alone or in combination at early or mid Dec., was more effective in increasing fruit set and fruit retention percentages than unsprayed trees (control) which gained the least percentages in most cases and the highest flower drop percentage. Accordingly and from the economic view, we can suggest to spray Siddek and Kiett mango trees with urea at 1.5% at early or mid Dec. for increasing fruit set and fruit retention percentages and consequently increasing fruit yield/tree.

**Key words**: *Mangifera indica*, siddek, kitte, $GA_3$, urea, spraying date, bud induction, infloresence.

## INTRODUCTION

Mango (*Mangifera indica* L.) is a major fruit crop of the tropical and subtropical regions of the world. However, its delicious taste, and unique flavour with high nutritional value have made it equally popular across the globe and led to call it the king of the fruits (**Malik and Singh, 2006**). The area grown with mango in Egypt has enormously increased through the last decades reaching about 281153 fads. (1.4% of the world mango area) producing about 880875 tons with average of 4.150 tons/fad., (**Statistics of the Ministry of Agriculture, 2016**).

Mango flowers are born on terminal inflorescences (panicles) that are broadly conical and could reach 60 cm long on some varieties. Inflorescences usually have primary,secondary, and tertiary pubescent, cymose branches pale green to pink or red in color and bear hundreds of hermaphrodite and male flowers on the same inflorescence. The ratio between the hermaphrodite and male flowers (sex ratio) on an inflorescence varies with variety and season and is influenced by the temperature during inflorescence development (**Bally, 2006**).

Mango flowering model had three assumptions: Gibberellic acid (GA) is a floral inhibitor that

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prevents mature mango trees from flowering, decreased GA levels beyond a certain threshold leads to the development of floral initials probably through the accumulation of carbohydrates and floral bud break will occur when sprayed with "flower-inducing" chemicals like potassium nitrate, thiourea or ethylene (**Protacio *et al.*, 2009**). **Mutasa-Gottgens *et al.* (2009)** reported that gibberellins may be involved in the developmental events leading to reproductive competence, as well as in floral determination and commitment. Following floral initiation, a functional GA signaling pathway is not required for the specification and differentiation of floral organs, but is essential for the normal development of these organs, with the possible exception of the papillae (**Griffiths *et al.*, 2006**). **Wang *et al.* (2008)** revealed that urea fertilization enhances the improvement of various metabolic and physiological aspects in plants and can serve as a rapidly available N-source for plant growth.

For uptake urea in mango flower, urease enzyme may play the significant role although the metabolic aspects in flowering are not clarified. **Ghosh and Chattopadhyay (1999)** cleared that urea might be involved in enhancing the flowering, fertility and influencing the cellular metabolic process of mango trees. **Ebeed and Abd El-Migeed (2005)** reported that urea may induce the fertility and other characteristics regarding the flowering and fruit development of mango.

**Sanchez *et al.* (2004) and Vazques and Perez (2006)** revealed that the inhibition of flowering by gibberelin is normally associated with stimulation of vegetative growth, $GA_3$ promoted delay of flowers emergence until March.

**Nunez-Elisea and Davenport (1991)** revealed that spraying $GA_3$ at 200 ppm three weeks before the flowering period was effective in delaying and synchronizing flowering of Keitt mango trees and markedly delayed bud break and increased shoots as opposed to panicle development. Moreover, the delay of growth was greater with increasing $GA_3$ concentration.

**Nuñez-Elisea (1994) and Sanchez *et al.* (2004)** indicated that spraying Keitt mango trees with $GA_3$ during the period from September to January inhibited floral budding.

**Davenport and Smith (1997), Azam *et al.* (2007) and Singh (2009)** reported that spraying $GA_3$ at 200 or 300 mg/liter inhibited bud break when applied in December + January; inhibition was most persistent when applied during Nov. + Dec. + Jan. They added also that treating with $GA_3$ reduced in reproductive shoot.

**Hemant (2006)** cleared that application of urea at 4% was more effective in controlling the fruit drop, increased fruit retention percentage, maximizing number of fruits and yield of Dashehari mango trees. **Guillermo *et al.* (2007)** showed that spraying Kent mango trees with $GA_3$ at 40 ppm significantly increased fruit set percentage and reduced fruit drop.

**Vazquez-Valdivia e*t al.* (2009)** sprayed Ataulfo mango trees with $GA_3$ at 50 and 100 ppm during December. They observed that sprayed trees gave two flowering periods, the first in January-February (normal flowering) and the seacond in April-May (delayed flowering), while untreated trees gave the first flowering. Also, they added that $GA_3$ application, showed delayed flowering and reduced flower intensity. The $GA_3$ increased the presence of mixed shoots from 6 to 13%, as compared to control. They stated that $GA_3$ plays an important role in delaying mango flowering depending on $GA_3$ concentration and application time.

**Nkansah e*t al.* (2012)** indicated that $GA_3$ at 25 ppm increased fruit set and fruit retention percentages of Kiett mango trees. However, this work was planned on the hope that $GA_3$ and urea,singly or in combination may reduce the number of flowers per tree and consequently decrease the great depletion of the stored nutrient reserves from the trees during flowering process to be usefulled later by the emerged lower number of flowers on the whole tree .The effects of these treatments on vegetative growth, yield and fruit quality of Siddeq and Keitt mango cvs. were also considered.

## MATERIALS AND METHODS

This investigation was conducted throughout two successive seasons of 2014/ 2015 and 2015/ 2016 on 8 -year-old trees of Siddek and Kiett mango cultivars trees grafted on Succari rootstock. The trees were grown in a private mango

orchard located at Belbeis District, Sharkia Governorate, Egypt. The trees were spaced at 4 × 3 m in sandy soil under drip irrigation system. The usual agricultural practices for mango trees in the orchard were adapted to all trees. The experimental trees were subjected to the following treatments: Spraying with $GA_3$ at 50 and 100 ppm, urea at 1.5% alone or in combination with $GA_3$ at 100 ppm and spraying with water as a control.

The above mentioned 5 treatments were adapted to trees of Siddek and Kiett mango cultivars in the two seasons on three dates : 1st December, 15th December and 1st January. The responses of the tested trees to the applied treatments were evaluated through the following parameters:

### Sex Ratio

Number of male and hermaphrodite flowers per inflorescence were counted in three inflorescences, then sex ratio was calculated at full bloom according to the following equation: sex ratio = (hermaphrodite flowers ÷ male flowers) ×100.

### Fruit Set and Flower Drop Percentages

Ten inflorescences at the different tree directions were labeled. The average number of flowers on these inflorescenes were counted at the full bloom stage by the end of March in each season. After fruit set, by the end of April, the setted fruitlets were counted at the same inflorescences then fruit set and flower drop percentages were calculated. The remaining fruits on the previous labeled inflorescences were recounted before harvesting in the two seasons then fruit retention percentage was calculated according to the equation: fruit retention = (average number of fruits per inflorescence at harvest ÷ total number of flowers) × 100.

The experiments were set in a split split plot design with 3 replicates and 5 treatments. Where, $GA_3$ and urea treatments were randomly arranged in the main plots, mango cultivars was distributed in the sub plots and spraying dates were distributed in the sub sub plots.

The necessary inflorescences and fruit samples were obtained from three mango trees representing three replicates for each treatment.

The obtained data were subjected to analysis of variances (ANOVA) according to **Snedecor and Cochran (1980)** using M-STAT program. Differences between means were compared using Duncan's multiple range test at 0.05 level **(Duncan, 1958)**.

## RESULTS AND DISCUSSION

### Effect of $GA_3$, Urea and Spraying Date and Their Combinations on Floral Aspects of Siddek and Kiett Mango Varieties

#### Effect on sex ratio

Results in Table 1 reveal that there were significant varietal differences in the average of sex ratio of Siddek and Kiett mango trees in the two seasons. However, sex ratio of Siddek mango trees (61.50 and 62.23%) was significantly higher than that of Kiett mango ones (45.13 and 46.29%) in the first and second seasons, respectively.

As for the effect of the tested treatments, trees sprayed with $GA_3$ at 100 ppm and those treated with urea at 1.5% + $GA_3$ at 100 ppm recorded the highest sex ratio (70.20 and 65.69%) in the first season, respectively, without significant differences between them. Whereas, the highest sex ratio (73.86%) was gained by trees treated with urea at 1.5%, in the second season. The lowest sex ratio (33.86 and 45.28%) was recorded for trees sprayed with urea at 1.5% in the first season and those treated with urea at 1.5% + $GA_3$ at 100 in the second one, respectively. The other tested treatments resulted intermediate ratios. This result is in line with those of **Shawky *et al*. (1980 and 1982)**.

Concerning the effect of spraying date, the results showed that the sex ratio of both tested mango varieties were significantly affected by spraying date in the two seasons. Anyhow, the highest sex ratio (59.77 and 59.97%) was recorded for trees sprayed on mid Dec., in the first and second seasons, respectively. The trees were sprayed on early Dec. and early Jan., gained the lowest sex ratio without significant differences among them, in the two seasons, respectively. This refers that sex ratio was significantly increased with spraying mango trees on mid of Dec. and addversely related with number of flowers/ inflorescence.

**Table 1. Effect of $GA_3$, urea, spraying date and their interactions on sex ratio of Siddek and Kiett mango varieties (2014/2015 and 2015/2016 seasons)**

| Variety (V) | Treatment (T) | First season (2014 / 2015) | | | Treat. av. | Second season (2015/2016) | | | Treat. av. |
|---|---|---|---|---|---|---|---|---|---|
| | | Spraying date (S) | | | | Spraying date (S) | | | |
| | | Early Dec. | Dec. 15 | Early Jan. | | Early Dec. | Dec. 15 | Early Jan. | |
| Siddek | Control | 56.90 g-j | 56.90 g-j | 56.90 g-j | 56.90 bc | 80.21 bc | 80.21 bc | 80.21 bc | 80.21 a |
| | $GA_{3\ 50\ ppm}$ | 37.36 kl | 57.78 f-j | 47.93 jk | 47.69 cd | 24.88 l | 81.66 b | 44.16 ij | 50.23 c |
| | $GA_{3\ 100\ ppm}$ | 68.43 c-f | 76.28 bcd | 82.95 b | 75.89 a | 51.85 hi | 68.05 def | 52.35 ghi | 57.42 bc |
| | Urea 1.5 % | 48.93 ij | 58.85 e-i | 30.29 lm | 46.02 d | 77.75 bcd | 93.48 a | 79.33 bc | 83.50 a |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 78.68 bc | 95.81 a | 68.49 cdef | 80.99 a | 28.53 kl | 61.57 e-h | 29.32 kl | 39.80 d |
| Variety av. | | 58.06 b | 69.12 a | 57.31 b | 61.50 A | 52.64 c | 76.98 a | 57.07 b | 62.23 A |
| Kiett | Control | 32.66 lm | 32.66 lm | 32.66 lm | 32.66 e | 35.49 jkl | 35.49 jkl | 35.49 jkl | 35.49 d |
| | $GA_{3\ 50\ ppm}$ | 30.65 lm | 82.88 b | 55.77 hij | 56.43 bcd | 53.05 ghi | 44.86 ij | 29.23 kl | 42.38 d |
| | $GA_{3\ 100\ ppm}$ | 69.43 cde | 57.11 g-j | 66.97 d-g | 64.51 b | 39.63 jk | 37.94 jk | 38.26 jk | 38.61 d |
| | Urea 1.5 % | 14.40 n | 15.66 n | 35.04 lm | 21.70f | 64.26 ef | 58.58 fgh | 69.80 cde | 64.21 b |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 62.13 e-h | 63.81 e-h | 25.19 mn | 50.38 cd | 63.41 efg | 37.88 jk | 50.95 hi | 50.75 c |
| Variety av. | | 41.86 c | 50.42 b | 43.13 c | 45.13 B | 51.17 c | 42.95 d | 44.75 d | 46.29 B |
| Control | | 44.78 de | 44.78 de | 44.78 de | 44.78C | 57.85 bc | 57.85 bc | 57.85 bc | 57.85 B |
| $GA_{3\ 50\ ppm}$ | | 34.01 f | 70.33 bc | 51.85 d | 52.06 B | 38.96 fg | 63.26 b | 36.69 g | 46.30 C |
| $GA_{3\ 100\ ppm}$ | | 68.93 bc | 66.69 c | 74.96 ab | 70.20A | 45.74 ef | 52.99 cd | 45.31 ef | 48.01 C |
| Urea 1.5 % | | 31.67 f | 37.26 ef | 32.66 f | 33.86 D | 71.00 a | 76.01 a | 74.57 a | 73.86 A |
| Urea 1.5% + $GA_{3\ 100\ ppm}$ | | 70.41 bc | 79.81 a | 46.84 d | 65.69 A | 45.97 def | 49.73 de | 40.14 fg | 45.28 C |
| Spraying date av. | | 49.96 B | 59.77 A | 50.22 B | | 51.91 B | 59.97 A | 50.91 B | |

Means having the same letter (S) in each colum are insignificantly different.

The interaction between mango varieties and spraying treatments were significant in the two seasons. Sex ratio of Siddek mango trees sprayed with $GA_3$ at 100 ppm and urea at 1.5% + $GA_3$ at 100 ppm gained the highest sex ratio (75.89 and 80.99%) in the first season, respectively. While, in the second season the highest sex ratio of Siddek mango trees (80.21 and 83.50%) was recorded for control trees and those sprayed with urea at 1.5%, respectively, without significant differences among them. The lowest sex ratio was induced by Kiett mango trees sprayed with urea at 1.5% (21.70%) in the first season and control (35.49%) in the second one. The other combinations exhibited intermediate sex ratios.

The interaction between mango varieties and spraying dates were significant in the two seasons. However, the highest sex ratio was recorded for Siddek mango trees sprayed on mid Dec. (69.12 and 76.98%) in the first and second seasons, respectively. The lowest sex ratio was gained by Kiett mango trees sprayed on early and mid Dec. (41.86 and 42.95%) in the two seasons, respectively. The other combinations produced inbetween sex ratios.

The interaction between spraying treatments and spraying dates were significant in both seasons. Sex ratio values of trees sprayed with urea at 1.5% + $GA_3$ at 100 ppm on mid Dec. gained the highest sex ratio (79.81%) without

significant differences than those sprayed with $GA_3$ at 100 ppm on early Jan.(74.96%) in the first season. But in the second ones, trees sprayed with urea at 1.5% on all tested spraying dates recorded the highest sex ratio without significant differences among them. The lowest sex ratio was recorded for trees sprayed with $GA_3$ at 50 ppm on early Dec. and those sprayed with urea at 1.5% on all tested spraying dates without significant differences among them, in the first season. Trees sprayed with $GA_3$ at 50 ppm on early Dec. and early Jan. and those treated with urea at 1.5% + $GA_3$ at 100 ppm on early Jan., Induced the least sex ratio without significant differences among them in the second season. The other combinations gained intermediate sex ratios.

The interaction between the three tested factors was significant in the two seasons. In the first season, the uppermost sex ratio (95.81%) was recorded for Siddek trees sprayed with urea at 1.5% + $GA_3$ at 100 ppm on mid Dec. In the second season, Siddek trees sprayed with urea at 1.5% on mid Dec. exhibited the highest sex ratio (93.43%). The lowest sex ratio was gained by Kiett trees treated with urea at 1.5% on early and mid Dec. (14.40 and 15.66%) in the first season and Siddek trees sprayed with $GA_3$ at 50 ppm on early Jan. (24.88%) and those treated with urea at 1.5% + $GA_3$ at 100 ppm on early Dec. and early Jan., (28.53 and 29.32%) without significant differences among them in the second season. Moreover, unsprayed trees (control) and those sprayed with $GA_3$ at 100 ppm through all spraying date recorded the least sex ratios without significant differences among them. The other combinations produced intermediate sex ratios in the two seasons.

**Effect on fruit set percentage**

Results in Table 2 reveal that there were significant varietal differences in fruit set percentage between Siddek and Kiett mango varieties in the first season only. As such, fruit set percentage of Siddek mango trees (0.29%) was significantly higher than that of Kiett ones (0.17%).

It is evident from Table 2 that, the studied $GA_3$ and urea treatments significantly affected fruit set percentage in both seasons. As such, trees sprayed with $GA_3$ at 100 ppm recorded the highest fruit set percentage (0.287%) without significant differences with those sprayed with urea at 1.5% + $GA_3$ at 100 ppm in the first season. Whereas, the lowest fruit set percentage was recorded by urea at 1.5% without significant differences with those treated with $GA_3$ at 50 ppm. The control treatment came inbetween. But in the second season, urea at 1.5% induced the hightest fruit set percentsge (0.278%) without significant differences with those of control (0.268%) and $GA_3$ at 50 ppm (0.206%) treatments. These results are in harmony with those of **Birendra e*t al.* (2006), Guillermo *et al*. (2007) and Nkansah e*t al.* (2012)** they found that spraying $GA_3$ at 25, 40 and 100 ppm enhanced fruit set of mango cvs.

The fruit set percentage of both tested mango varieties were significantly affected by spraying date in the two seasons. Anyhow, the highest fruit set percentage (0.247%) was gained by trees sprayed on mid Dec. in the first season, without significant differences with those sprayed on early Jan. (0.228%). The lowest fruit set percentage was induced by trees sprayed on early Dec. without significant differences with those sprayed on early Jan. whereas, in the second season, sprayed trees on early Dec. exhibited the highest fruit set percentage (0.274%) without significant differences with those sprayed on mid Dec., followed in descendgly order by those sprayed on mid Dec. (0.222%) and early Jan. (0.192%).

The interaction between mango varieties and spraying treatments were significant in both seasons. In the first season, Siddek mango trees sprayed with $GA_3$ at 100 ppm gained the highest fruit set percentage (0.382%) while, the lowest fruit set percentage (0.092%) was recorded by Kiett mango trees sprayed with urea at 1.5%. The other tested combinations recorded intermediate values. In the second season, unsprayed Kiett mango trees (control) gained the highest fruit set percentage (0.360%) without significant differences with those varieties sprayed with urea at 1.5%. The other tested combinations came in the second rank without significant differences among them in most cases.

**Table 2. Effect of $GA_3$, urea, spraying date and their interactions on fruit set percentage of Siddek and Kiett mango varieties (2014/2015 and 2015 /2016 seasons)**

| Variety (V) | Treatment (T) | First season (2014/2015) | | | Treat. av. | Second season (2015 / 2016) | | | Treat. av. |
|---|---|---|---|---|---|---|---|---|---|
| | | Spraying date (S) | | | | Spraying date (S) | | | |
| | | Early Dec. | Dec. 15 | Early Jan. | | Early Dec. | Dec. 15 | Early Jan. | |
| Siddek | Control | 0.280 d | 0.280 d | 0.280 d | 0.280 b | 0.177 f-j | 0.177 f-j | 0.177 f-j | 0.177 cd |
| | $GA_{3\ 50\ ppm}$ | 0.163 h-l | 0.210 d-j | 0.270 de | 0.214 cd | 0.180 f-i | 0.253 c-f | 0.153 g-k | 0.196 bcd |
| | $GA_{3\ 100\ ppm}$ | 0.283 d | 0.600 a | 0.263 de | 0.382 a | 0.330 abc | 0.267 c-f | 0.207 d-g | 0.268 abc |
| | Urea 1.5 % | 0.367 c | 0.253 def | 0.180 f-k | 0.267 bc | 0.383 a | 0.290 bcd | 0.147 g-k | 0.273 abc |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 0.247 d-g | 0.213 d-i | 0.470 b | 0.310 b | 0.257 c-f | 0.227 d-g | 0.277 b-e | 0.253 bc |
| Variety av. | | 0.268 b | 0.311 a | 0.293 ab | 0.291 A | 0.265 a | 0.243 ab | 0.192 c | 0.233 A |
| Kiett | Control | 0.193 e-k | 0.193 e-k | 0.193e-k | 0.193 d | 0.360 ab | 0.360 ab | 0.360 ab | 0.360 ab |
| | $GA_{3\ 50\ ppm}$ | 0.130 j-m | 0.197 e-k | 0.203 d-j | 0.177 d | 0.230 d-g | 0.233 d-g | 0.187 e-i | 0.217 bcd |
| | $GA_{3\ 100\ ppm}$ | 0.147 i-l | 0.260 def | 0.170 g-l | 0.192 d | 0.193 e-h | 0.080 k | 0.100 ijk | 0.124 d |
| | Urea 1.5 % | 0.123 klm | 0.057 m | 0.097 lm | 0.092 e | 0.397 a | 0.227 d-g | 0.223 d-g | 0.282 ab |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 0.230 d-h | 0.203 d-j | 0.153 i-l | 0.196 d | 0.230 d-g | 0.107 h-k | 0.087 jk | 0.141 d |
| Variety av. | | 0.165 c | 0.182 c | 0.163 c | 0.170 B | 0.282 a | 0.201 bc | 0.191 c | 0.225 A |
| Control | | 0.237 c | 0.237 c | 0.237 c | 0.237 B | 0.268 b | 0.268 b | 0.268 b | 0.268 AB |
| $GA_{3\ 50\ ppm}$ | | 0.147 e | 0.203 cd | 0.237 c | 0.196 C | 0.205 bcd | 0.243 bc | 0.170 d | 0.206 AB |
| $GA_{3\ 100\ ppm}$ | | 0.215 c | 0.430 a | 0.217 c | 0.287 A | 0.262 b | 0.173 d | 0.153 d | 0.196 B |
| Urea 1.5% | | 0.245 c | 0.155 de | 0.138 e | 0.179 C | 0.390 a | 0.258 b | 0.185 cd | 0.278 A |
| Urea 1.5% + $GA_{3\ 100\ ppm}$ | | 0.238 c | 0.208 cd | 0.312 b | 0.253 AB | 0.243 bc | 0.167 d | 0.182 cd | 0.197 B |
| Spraying date av. | | 0.216 B | 0.247 A | 0.228 AB | | 0.274 A | 0.222 A | 0.192 C | |

Means having the same letter (S) in each colum are insignificantly different.

The interactions between mango variety and spraying date was significant in the two seasons. However, the highest fruit set percentage was recorded for Siddek mango trees sprayed on mid Dec. (0.311%) without significant differences with those sprayed on early Jan. in the first season. Whereas, the lowest fruit set percentage was recorded for Kiett mango trees sprayed on early Jan. (0.163%) without significant differences with those sprayed on early or mid Dec. While in the second season, trees of both tested cvs. sprayed on early Dec. gained the highest fruit set percentage without significant differences with those of Siddek cv. sprayed on mid Dec.

The interaction between treatments and spraying date was significant in the two seasons. In the first season, fruit set percentage of trees treated by $GA_3$ at 100 ppm in the second spraying date (mid Dec.) gained the highest fruit set percentage (0.430%), whereas the lowest fruit set percentage (0.138%) was recorded for trees treated by urea 1.5% on early Jan. without significant differences with those sprayed with urea at 1.5% on mid Dec. and those sprayed with $GA_3$ at 50 ppm on early Dec. In the second season, the highest fruit set percentage (0.390%), was recorded for trees sprayed with urea at 1.5% on early Dec. The other tested combinations gained lower percentages without

significant differences between them in most cases.

The interactions between the three tested factors was significant in the two seasons. In the first season, the highest most fruit set percentage (0.60%) was produced by Siddek variety treated with $GA_3$ at 100 ppm on mid Dec. Whereas, the lowest fruit set percentage (0.057%) was recorded for Kiett variety treated with urea at 1.5% on mid Dec. The other tested combinations came inbetween. In the second season, the highest fruit set percentage (0.383 and 0.397%) was recorded for the two varieties Siddek and Kiett sprayed with urea at 1.5% on early Dec. without significant differences with those of control (0.360%) on the different dates. The other tested combinations came in the second rank without significant differences between them in most cases.

**Effect on flower drop percentage**

Results in Table 3 show that there were significant varietal differences in flower drop percentage of Siddek and Kiett mango varieties in the first season only. As such, flower drop percentage of Siddek mango trees (98.20%) was significantly higher than that of Kiett mango ones (95.87%) in the first season.

As shown in Table 3, the tested spraying treatments significantly affected flower drop percentage in the two seasons. As such, control treatment recorded the highest flower drop percentage (98.29 and 97.69%) in the first and second seasons, respectively, without significant differences with those sprayed with $GA_3$ at 50 ppm and urea at 1.5% + $GA_3$ at 100 ppm in both seasons. Whereas, the lowest flower drop percentage (95.86 and 94.92%) was recorded for trees sprayed with urea at 1.5% without significant differences with those sprayed with $GA_3$ at 100 ppm and urea at 1.5% + $GA_3$ at 100 ppm in both tested seasons. The obtained findings are in agreement with those of **Yadav *et al.* (2004), Hemant (2006) and Guillermo *et al.* (2007)**.

As for the effect of spraying date on the considered parameter, results in Table 3 reveal that flower drop percentage of both tested mango varieties were significantly affected by spraying date in the second season only. Anyhow, the highest flower drop percentage (96.99 and 96.60%) were recorded for trees sprayed on early and mid Dec. without significant differences between them. The lowest flower drop percentage was induced by trees sprayed on early Jan (94.84%) without significant differences with those sprayed on mid Dec.

The interactions between mango varieties and spraying treatments was significant in both seasons. Since, unsprayed Siddek mango trees (control) gained the highest flower drop percentage (98.62 and 97.20%) in the first and second seasons, respectively, without significant differences with all tested treatments in the two seasons in most cases. At the same time, untreated trees (control) recorded the highest flower drop percentage (97.95 and 98.19%) in the first and second seasons, respectively, without significant differences with those treated with $GA_3$ at 50 ppm in both seasons. The least flower drop percentage (93.48 and 94.81%) was recorded for Kiett mango trees sprayed with urea at 1.5% in the first and second seasons, respectively.

The interactions between mango varieties and spraying dates on flower drop percentage was significant in the two seasons. However, the highest flower drop percentage was recorded for Siddek mango trees within all spraying dates without significant differences between them. Whereas, the lowest flower drop percentage was recorded for Kiett mango trees sprayed on mid Dec. (95.20%) without significant differences with those sprayed on early Dec. (95.81%). Kiett mango trees sprayed on early Jan. exhibited the least flower drop percentage (94.08%) without significant differences with those sprayed on mid Dec. in the second season.

The interactions between the tested treatments and spraying dates was significant in the two seasons. As such, almost all spraying treatments on all spraying dates recorded the highest flower drop percentages with values ranged from 96.19 - 98.29% in the first season, and 94.32 - 97.69% in the second one. Except those sprayed with urea at 1.5% on mid-Dec., and $GA_3$ at 100 ppm on early Dec., in the first season and those sprayed with urea at 1.5% on early Jan., in the second one.

**Table 3. Effect of $GA_3$, urea and spraying date and their interactions on flower drop percentage of Siddek and Kiett mango varieties (2014/2015 and 2015/2016 seasons)**

| Variety (V) | Treatment (T) | First season ( 2014 / 2015 ) | | | Treat. av. | Second season ( 2015 / 2016 ) | | | Treat. av. |
|---|---|---|---|---|---|---|---|---|---|
| | | Spraying date (S) | | | | Spraying date (S) | | | |
| | | Early Dec. | Dec. 15 | Early Jan. | | Early Dec. | Dec. 15 | Early Jan. | |
| Siddek | Control | 98.62 ab | 98.62 ab | 98.62 ab | 98.62 a | 97.20 ab | 97.20 ab | 97.20 ab | 97.20 ab |
| | $GA_3$ 50 ppm | 97.71 ab | 98.31 abc | 97.67 abc | 97.90 a | 96.24 ab | 96.71 ab | 95.93 ab | 96.29 ab |
| | $GA_3$ 100 ppm | 96.30 a-d | 97.64 abc | 98.78 ab | 97.57 ab | 95.56 ab | 96.57 ab | 95.18 ab | 95.77 ab |
| | Urea 1.5% | 97.66 abc | 98.30 abc | 98.75 ab | 98.24 a | 96.73 ab | 96.72 ab | 91.64 bc | 95.03 ab |
| | Urea 1.5%+ $GA_3$ 100 ppm | 98.35 abc | 98.89 a | 98.70 abc | 98.65 a | 96.56 ab | 95.96 ab | 98.11 a | 96.88 ab |
| Variety av. | | 97.72 ab | 98.35 a | 98.50 a | 98.20 A | 96.46 ab | 96.63 ab | 95.61 ab | 96.23 A |
| Kiett | Control | 97.95 abc | 97.95 abc | 97.95 abc | 97.95 a | 98.19 a | 98.19 a | 98.19 a | 98.19 a |
| | $GA_3$ 50 ppm | 96.64 a-d | 96.27 a-d | 97.81 abc | 96.90 abc | 97.34 ab | 96.97 ab | 97.39 a | 97.23 ab |
| | $GA_3$ 100 ppm | 93.98 ef | 96.07 a-d | 96.06 bcd | 95.37 c | 96.65 ab | 94.32 ab | 93.47 abc | 94.91 b |
| | Urea 1.5% | 94.73 ef | 91.56 f | 94.16 ef | 93.48 d | 98.05 a | 98.01 a | 88.36 c | 94.81 b |
| | Urea 1.5% + $GA_3$ 100 ppm | 95.75 cde | 94.17 de | 97.00 a-d | 95.64 bc | 97.11 ab | 95.40 ab | 92.96 abc | 95.16 ab |
| Variety av. | | 95.81 cd | 95.20 d | 96.59 bc | 95.87 B | 97.53 a | 96.58 ab | 94.08 b | 96.06 A |
| Control | | 98.29 a | 98.29 a | 98.29 a | 98.29 A | 97.69 a | 97.69 a | 97.69 a | 97.69 A |
| $GA_3$ 50 ppm | | 97.17 ab | 97.29 a | 97.74 a | 97.40 AB | 96.79 a | 96.84 a | 96.66 a | 96.76 AB |
| $GA_3$ 100 ppm | | 95.14 bc | 96.85 abc | 97.42 a | 96.47 BC | 96.26 a | 95.45 a | 94.32 a | 95.34 B |
| Urea 1.5 % | | 96.20 abc | 94.93 c | 96.46 abc | 95.86 C | 97.39 a | 97.37 a | 89.99 b | 94.92 B |
| Urea 1.5% + $GA_3$ 100 ppm | | 97.05 ab | 96.53 abc | 97.85 a | 97.14 ABC | 96.84 a | 95.68 a | 95.54 a | 96.02 AB |
| Spraying date av. | | 96.77 A | 96.77 A | 97.55 A | | 96.99 A | 96.60 AB | 94.84 B | |

Means having the same letter (S) in each colum are insignificantly different.

The interactions between the three tested factors on flower drop percentage was significant in the two seasons. Anyhow, Siddek mango trees treated with the tested spraying treatments within the three spraying dates recorded the highest flower drop percentage with values between 96.30 to 98.89% in the first season, and 95.18 to 98.11% in the second one, except, those sprayed with urea at 1.5% on early Jan. in the second season (91.64%). As for, untreated trees (control) and those sprayed with $GA_3$ at 50 ppm during all spraying dates and those sprayed with $GA_3$ at 100 ppm on mid Dec. and urea at 1.5% + $GA_3$ at 100 ppm recorded the highest flower drop percentages ranging between 96.07 to 97.95% in the first season. Whereas, Kiett mango trees sprayed with urea at 1.5% on all tested spraying dates and those sprayed with $GA_3$ at 100 ppm on early Dec. recorded the lowest flower drop percentage with values ranging between 91.56 to 94.73%.

**Effect on fruit retention percentage**

Results in Table 4 show that there were no significant varietal differences in fruit retention percentage between Siddek and Kiett mango varieties in both tested seasons. As such, fruit retention percentages were (0.035 and 0.075%) and (0.047 and 0.056%) for Siddek and Kiett mango varieties in the first and second seasons, respectively.

**Table 4. Effect of $GA_3$, urea, spraying date and their interactions on fruit retention percentage of Siddek and Kiett mango varieties (2014/2015 and 2015/2016 seasons)**

| Variety (V) | Treatment (T) | First season ( 2014 / 2015 ) | | | Treat. av. | Second season ( 2015 / 2016 ) | | | Treat. av. |
|---|---|---|---|---|---|---|---|---|---|
| | | Spraying date (S) | | | | Spraying date (S) | | | |
| | | Early Dec. | Dec. 15 | Early Jan. | | Early Dec. | Dec. 15 | Early Jan. | |
| Siddek | Control | 0.030 efg | 0.030 efg | 0.030 efg | 0.030 b | 0.043 de | 0.043 de | 0.043 de | 0.043 c |
| | $GA_{3\ 50\ ppm}$ | 0.040 c-g | 0.033 d-g | 0.057 a-d | 0.043 ab | 0.067 b-e | 0.083 a-e | 0.063 cde | 0.071 bc |
| | $GA_{3\ 100\ ppm}$ | 0.037 d-g | 0.033 d-g | 0.033 d-g | 0.034 b | 0.117 ab | 0.083 a-e | 0.060 cde | 0.087 ab |
| | Urea 1.5 % | 0.030 efg | 0.047 b-g | 0.030 efg | 0.036 b | 0.100 abc | 0.093 a-d | 0.123 a | 0.106 a |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 0.043 b-g | 0.027 efg | 0.027 efg | 0.032 b | 0.077 a-e | 0.093 a-d | 0.040 e | 0.070 bc |
| Variety av. | | 0.036 a | 0.034 a | 0.035 a | 0.035 A | 0.081 a | 0.079 a | 0.066 a | 0.075 A |
| Kiett | Cotrol | 0.040 c-g | 0.040 c-g | 0.040 c-g | 0.040 ab | 0.067 b-e | 0.067 b-e | 0.067 b-e | 0.067 bc |
| | $GA_{3\ 50\ ppm}$ | 0.043 b-g | 0.043 b-g | 0.050 b-e | 0.046 ab | 0.063 cde | 0.060 cde | 0.047 de | 0.057 c |
| | $GA_{3\ 100\ ppm}$ | 0.080 a | 0.067 ab | 0.023 fg | 0.057 a | 0.050 cde | 0.050 cde | 0.060 cde | 0.053 c |
| | Urea 1.5% | 0.050 b-e | 0.063 abc | 0.057 a-d | 0.057 a | 0.073 a-e | 0.043 de | 0.057 cde | 0.058 c |
| | Urea 1.5% + $GA_{3\ 100\ ppm}$ | 0.033 d-g | 0.023 fg | 0.047 b-f | 0.034 b | 0.047 de | 0.047 de | 0.050 cde | 0.048 c |
| Variety av. | | 0.049 a | 0.047 a | 0.043 a | 0.047 A | 0.060 a | 0.053 a | 0.056 a | 0.056 A |
| Cotrol | | 0.035 efg | 0.035 efg | 0.035 efg | 0.035 AB | 0.055 ab | 0.055 ab | 0.055 ab | 0.055 B |
| $GA_{3\ 50\ ppm}$ | | 0.042 b-f | 0.038 d-g | 0.053 abc | 0.044 AB | 0.065 ab | 0.072 ab | 0.055 ab | 0.064 AB |
| $GA_{3\ 100\ ppm}$ | | 0.058 a | 0.050 a-d | 0.028 fg | 0.046 A | 0.083 a | 0.067 ab | 0.060 ab | 0.070 AB |
| Urea 1.5 % | | 0.040 c-f | 0.055 ab | 0.043 b-e | 0.046 A | 0.087 a | 0.068 ab | 0.090 a | 0.082 A |
| Urea 1.5% + $GA_{3\ 100\ ppm}$ | | 0.038 d-g | 0.025 g | 0.037 d-g | 0.033 B | 0.062 ab | 0.070 ab | 0.055 ab | 0.059 B |
| Spraying date av. | | 0.043 A | 0.041 A | 0.039 A | | 0.070 A | 0.066 A | 0.061 A | |

Means having the same letter (S) in each colum are insignificantly different.

Results in Table 4 reveal also that, fruit retention percentage was significantly affected by the tested spraying treatments in both seasons. As such, urea at 1.5% recorded the highest fruit retention percentage (0.046 and 0.082%) in both seasons, respectively without significant differences with that of control treatment in the first season and $GA_3$ at 50 or 100 ppm in both seasons. In the second rank came those sprayed with urea at 1.5%+ $GA_3$ at 100 ppm (0.033 and 0.059%) in both seasons, respectively, without significant differences with that of control treatment and those treated by $GA_3$ at 50 ppm in both seasons. The obtained results confirm with those of **Rajput and Tiwari (1977), Singh (1977) and Singh (1984), Rajput and Singh (1983 and 1989), Singh *et al.* (1991), Birendra e*t al.* (2006) and Hemant (2006)**.

Results of Table 4 clear that spraying date was of no significant effect on fruit retention percentage of Kiett and Siddek mango cvs. in both seasons.

As clear in Table 4, the interactions between mango varieties and spraying treatments on fruit retention percentage was significant in the two seasons. Kiett mango trees sprayed with urea at 1.5% or $GA_3$ at 100 ppm gained the same and the highest fruit retention percentage (0.057%) in the first season,without significant differences with untreated trees (control) and those sprayed

with $GA_3$ at 50 ppm. The differences between all combinations (Siddek cv. × all treatments) were significant in the first season. While, in the second season, Siddek mango trees sprayed with urea at 1.5% gained the highest fruit retention percentage (0.106%) without significant differences with those sprayed with $GA_3$ at 100 ppm. The lowest fruit retention were recorded from combination Siddek cv. × control treatment without significant differences with combination Siddek cv. × $GA_3$ at 50 ppm in the second season.

The interaction between mango varieties and spraying dates on fruit retention percentage was insignificant in both tested seasons.

The interaction between spraying treatments and spraying dates on fruit retention percentage were significant in the two seasons. As such, the highest fruit retention percentage (0.058 and 0. 050%) was recorded for trees sprayed with $GA_3$ at 100 ppm on early and mid Dec. without significant differences between them and those sprayed with and urea at 1.5% on mid Dec. (0.055%) and $GA_3$ at 50 ppm on early Jan. (0.053%). The lowest fruit retention percentage (0.025%) was recorded for trees sprayed with urea at 1.5% + $GA_3$ at 100 ppm on mid Dec. without significant differences with almost all other combinations in the first season. In the second season, the highest fruit retention percentage (0.090%) was recorded for trees sprayed with urea at 1.5% on early Jan. without significant differences with all almost other combinations.

Table 4 shows also that, the interaction between the three tested factors on fruit retention percentage was significant in the two seasons and reflect the individual effect of each factor on fruit retention percentage.

It is quite evident from the previous trends that spraying Siddek and Kiett mango trees with $GA_3$ at 100 ppm or urea at 1.5% either alone or in combination on early or mid Dec. was more effective in increasing fruit set and fruit retention percentages than unsprayed trees (control) which gained the least percentage in most cases and the highest flower drop percentage.

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# استجابة أشجار المانجو صنف صديق وكيت للرش بحمض الجبريللين واليوريا فى مرحلة الدفع الزهرى أ- الخصائص الزهرية

**أسامه خليل محمد نوح - طلعت على محمد أبو سيد أحمد - أحمد سيد أحمد حسن - فريد سامى محسن**

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أجريت هذه الدراسة خلال موسمى ٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ على أشجار المانجو صنف صديق وكيت عمر ٨ سنوات مطعومة على أصل السكرى ومتماثلة فى قوة النمو قدر الإمكان ومزروعة فى تربة رملية على مسافة ٤× ٣ م تحت نظام الرى بالتنقيط فى مزرعة مانجو خاصة بمركز بلبيس محافظة الشرقية، تم رش أشجار التجربة بالجبريللين بتركيز صفر، ٥٠ ، ١٠٠ جزء فى المليون واليوريا بتركيز ١,٥% إما منفردة أو مخلوطة مع الجبريللين بتركيز ١٠٠ جزء فى المليون فى ثلاث مواعيد على فترات نصف شهرية (أول ومنتصف ديسمبر وأول يناير)، أظهرت النتائج أن النسبة الجنسية ونسبة عقد الثمار ونسبة تساقط الأزهار كانت أكبر فى صنف الصديق عنها فى صنف الكيت، أعطت الأشجار التى تم رشها فى منتصف ديسمبر أعلى نسبة جنسية وأعلى نسبة عقد، أما الأشجار التى تم رشها فى أول ديسمبر فقد حققت أكبر نسبة لتساقط الأزهار مقارنة بالمواعيد الأخرى، تأثرت نسبة بقاء الثمار معنوياً بكلاً من الصنف وموعد الرش خلال موسمى الدراسة، أعطت الأشجار التى تم معاملتها باليوريا بتركيز ١,٥% أو الجبريللين بتركيز ١٠٠ جزء فى المليون أعلى قيم للنسبة الجنسية ونسبة العقد ونسبة بقاء الثمار، بينما أظهرت الأشجار غير المعاملة (الكنترول) وتلك التى تم رشها بالجبريللين بتركيز ٥٠ جزء فى المليون أعلى نسبة لتساقط الأزهار، أوضحت النتائج أن رش أشجار المانجو صنف (صديق وكيت) بالجبريللين بتركيز ١٠٠ جزء فى المليون أو اليوريا بتركيز ١,٥ % سواء منفردة أو مخلوطة فى بداية أو منتصف ديسمبر أدت إلى زيادة نسبة عقد وبقاء الثمار مقارنة بالأشجار غير المعاملة (الكنترول) والتى أظهرت أكبر نسبة لتساقط الأزهار، وبناءً على ذلك ومن الوجهة الاقتصادية يمكن التوصية برش أشجار المانجو صنفى صديق وكيت باليوريا بتركيز ١,٥% فى بداية أو منتصف ديسمبر لزيادة نسبة عقد وبقاء الثمار على الأشجار وبالتالى زيادة المحصول.

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