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# INFLUENCE OF POST-SET SPRAY APPLICATION OF PUTRESCINE, $KNO_3$ AND CPPU ON FRUITS NUMBER, DROP RATE, RETENTION AND QUALITY OF MANGO CV. ALPHONSO

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## ABSTRACT

This investigation was conducted on 20 year old mango trees ( *Mangifera Indica L.* ) cultivar Alphonso. Panicles were sprayed two weeks after fruit set with putrescine at 150, 300 or 450 ppm, $KNo_3$ at 0.5, 1 or 2% or CPPU at 5, 10 or 15 ppm. Results indicated that both putrescine and $KNo_3$ significantly increased number of fruits per panicle. There was a direct relationship between the concentration and the number of retained fruits. putrescine recorded the lowest rate of fruit drop followed by $KNo_3$ and CPPU. Putrescine treatments significantly increased percentage of fruit retention at harvest. CPPU treatments increased firmness, weight, length, diameter and width of the fruit. Putrescine and $KNO_3$ increased TSS%. However, there was a negative association between the concentration of CPPU and TSS%. Fruit acidity increased with CPPU and putrescine application. However, it decreased with $KNO_3$. TSS/ Acid ratio increased with putrescine and $KNO_3$. The highest value of vitamin C was recorded with 2% $KNO_3$ and the lowest one occurred with CPPU at 15 ppm.

**Key words:** Mango, *Mangifera Indica*, Fruit retention, Fruit quality, CPPU, Putrescine, $KNo_3$

## INTRODUCTION

There are different commercial mango cultivars of great important grown in Egypt, Mango cv Alphonso. is considered one of the most promising cvs for exportation to the main foreign market widows in Eroupe, i.e., France, UK, Germany and Holland. Its fruit is characterized by medium size, up to 10 cm. long, 350 g in weight, has kidney shape and thick, yellow orange skin, orange flesh, firm, fiberless flesh, small monoembryonic seed and harvest season August. These characteristics makes it one of the market preferred cultivars.

In many commercial mango cultivars, a disastrously high fruits drop, amounting to 99% loss of fruitlets, is often observed. Consequently, post-set fruit drop and low yield, are major problem in commercial mango orchard. Several investigations have been directed to overcome the dependence upon environmental signal for flower initiation using different cultivars, different management strategies and chemical sprays. Oosthuyse (1993) enhanced fruit retention and tree yield by spraying CPPU on Tommy Atkins mango trees.

The present study was initiated to evaluate the effect of post fruit set foliar spray of putrescine, potassium nitrate or sitofex (CPPU) on number of fruits, fruit drop, fruit retention and fruit quality of mango CV. Alphonso.

## MATERIALS AND METHODS

This study has been carried out during two successive seasons of 1997 and 1998. The Alphonso mango trees used in this investigation were grown under Giza Governorate conditions. The selected trees in the two seasons of the study were in the on year and about 20 years old, grafted on seedling rootstocks and planted at 6 meter apart. The trees nearly were similar in vigor, size and subjected to the same cultural practices. The trees under investigation were planted among different mango cvs. to ensure an adequate pollination and fertilization. The orchard contained the cvs. Alphonso, Hindy khassa, Zebda, Mabrouka and Balady. Twenty panicles per replicate were sprayed two weeks after fruit set with Putrescine ( tetra methylene – diamine ( $C_4 H_{12}$- 2HCl ) ) at 150, 300 and 450 PPM, Potassium nitrate ($KNo_3$ ) at 0.5, 0.1 and 2% or CPPU {(N-(2-chloro-4-pyridyl-N-phenyl-urea) $C_{12} H_{10} ClNo_3$, ( Sitofex)} at 5, 10 and 15 PPM.

Number of fruit per panicle was counted at couple - week intervals from fruit set up to harvesting time.

Rate of fruit drop was calculated at couple - week intervals from spraying date (two weeks after fruit set) up to harvesting time.

Fruit retention percentage was recorded at harvesting as follows:

$$\text{Fruit retention percentage} = \frac{\text{No. of mature fruits per panicle}}{\text{No. of setting fruits per panicle}} \times 100$$

Physical and chemical fruit characters were measured at harvesting. Nine fruits representing each treatment were taken for such measurement.

**Physical characters**

Fruit weight (g), fruit firmness (kg/ $cm^2$), fruit length (cm), and highest fruit diameter (cm), fruit width (cm) and fruit shape (length/ diameter ) (L/D) were determined.

**Chemical characters**

- Total soluble solid % was determined using a hand refractometer.
- Fruit acidity % was determined as citric acid content using fresh juice with titrated against 0.1 NaOH in the presence of phenolphthalein dye as indicator A.O.A.C. (1975)..
- TSS acid ratio.
- Vitamin “C” was determined as milligrams of ascorbic acid per 100 g juice using 2,6-dichloro phenol indophenol dye according to A.O.A.C. (1975).

**Design of the experiment and statistical analysis**

A complete randomize design was used, each treatment was replicated three times, with one tree for each replicate. Data were tabulated and statistically analyzed according to Snedecor and Cochran ( 1980). Means were compared by L.S.D at 5% .

## RESULTS AND DISCUSSION

**Number of fruit**

It is noted from the data in Tables ( 1 & 2 ) that, putrescine and $KNo_3$ significantly increased the retained number of fruits / panicle in both seasons of study. Moreover, $KNo_3$ treatment was more effective than putrescine in this regard. The retained number of fruits / panicle increased with increasing $KNo_3$concentration. These results are in line with those reported by Sharma *et al. (*1990) as spraying mango cv. Langra with 3% $KNo_3$ produced greater number of fruits / plant than 1.5%.

It is evident also that increasing the concentration of putrescine was effective in increasing the retained number of fruits / panicle. This result is supported by Eddo and Massima *(*1985) and Rugini (1986) who found that, putrescine increased fruit set and yield of Apple and Olive when was applied at full bloom or after full bloom.

The results also revealed that there was a negative relationship between CPPU concentration and the retained number of fruits / panicle. Average number significantly decreased from 15 up to 75 days from setting, as it decreased from (12.75 and 13.76) to (.70 & 1.71) during the two seasons respectively. Nevertheless, this decrease continued until fruit reached maturity, but insignificantly.

**Fruit retention**

Data in Tables (3 & 4) indicate that, all treatments increased percentage of fruit retention at harvest. The highest percentage were recorded with putrescine specialy at 450 ppm they were in the two seasons of study 17.08 and 21.62 respectively. These results agreed with Zora *et al. (*1995), as Putrescine increased fruit retention in mango cv. Dashehari.
Also $KNo_3$ significantly increased fruit retention percentage than the control in the two seasons. Oosthuyse (1996) reported that spraying mango cv. Kent with 2% $KNo_3$, increased fruit retention.

CPPU lowered fruit retention percentage if compared with Putrescine or $KNo_3$. CPPU slightly increased fruit retention in the first season but notably in the second one. The findings of Oosthuyse (1993) and Oosthuyse (1995) with Tommy Atkins mango are in disagreement with the obtained results.

There is a direct relationship between the concentrations of putrescine and $KNo_3$ and the percentage of fruit retention, contrarily a negative relationship between CPPU concentration and fruit retention was noted. These findings are in accordance with that obtained by Costa et al (1984) on apple cv. Rubysure, Eddo and Massima, *(*1985) on Leccino and Pendolino olive However, Sharma *et al. (*1990) concluded that, spraying mango cv. Langra with 3% $KNo_3$ increased yield than $KNo_3$ at 1.5 %

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**Table (3): Effect of post set spray of putrescine, $KNo_3$ and CPPU on percentage of fruit retention (season 1997).**

| Substances | | | | | | | | | Control |
|---|---|---|---|---|---|---|---|---|---|
| Putrescine | | | $KNo_3$ | | | CPPU | | | |
| 150 ppm | 300 ppm | 450 ppm | 0.5% | 1% | 2% | 5 ppm | 10 ppm | 15 ppm | |
| 10.75 bcd | 10.88 bc | 17.08 a | 9.19 cde | 11.14 bc | 14.86 ab | 7.10 cde | 6.35 de | 5.67 e | 5.43 e |
| 12.9 A | | | 11.81 A | | | 6.37 B | | | 5.43 B |

**Values followed by the same letter in row are not statistically different at 5 % level**

**Table (4): Effect of post set spray of putrescine, $KNo_3$ and CPPU on percentage of fruit retention (season 1998).**

| Substances | | | | | | | | | control |
|---|---|---|---|---|---|---|---|---|---|
| Putrescine | | | $KNo_3$ | | | CPPU | | | |
| 150 ppm | 300 ppm | 450 ppm | 0.5% | 1% | 2% | 5 ppm | 10 ppm | 15 ppm | |
| 10.83 bc | 10.93 bc | 21.62 a | 9.42 bcd | 11.55 bc | 14.17 b | 11.2 bc | 7.79 cd | 7.31 cd | 4.71 d |
| 14.46 A | | | 11.71 AB | | | 8.76 B | | | 4.71 C |

**Values followed by the same letter in row are not statistically different at 5 % level**

**Fruit drop**

Data in Tables (5 & 6) indicate that all treatment decreased the average rate of fruit drop. This trend was detected in both seasons of study. Putrescine scored the lowest rate of fruit drop. No significant differences were noted between putrescine and $KNo_3$ effect. These results are supported by Paksasorn *et al*, (1995);and Tiburico *et al. (*1993) as fruit abscission is related to ethylene production as well as polyamines retarded ethylene production.

Although, $KNo_3$ significantly decreased drop compared to CPPU in the first season, CPPU insignificantly decreased this rate than $KNo_3$ in the second one. Differences were insignificant among the used concentrations. The findings of Antognozzi *et al. (*1993); Joublan *et al. (*1995) and Antognozzi *et al. (*1995) supported our results, they reported that CPPU failed to reduce fruit drop in kiwi, grape and olive treated trees.

The highest drop rate was recorded at 30 days from setting (47. 84 and 52.19) in the two seasons, respectively. Moreover fruit drop decreased continuously to (42.96 and 45.41) 30 to 45 day from setting in the same seasons, respectively, also fruit drop decreased continuously up to maturity. The findings of Dahshan and Habib (1985), are in accordance with our results.

**Fruit Physical Characters**

**Fruit firmness**

Data in Tables (7 and 8) obviously reveal that CPPU and $KNo_3$ significantly increased fruit firmness, whereas Putrescine decreased it. This trend was noted in both seasons of study. These results are in agreement

with the findings of Greene *et al. (*1993) as post bloom spray of CPPU at 5 PPM, increased fruit firmness of Delicious, MacIntosh and Empire apples.

Increasing CPPU concentration form 5 PPM to 10 or 15 PPM, significantly increased fruit firmness also, $KNo_3$ at 2% significantly increased fruit firmness than the other treatments, but fruit firmness was decreased with decreasing the concentration of Putrescine however, no significant differences were noted between the three concentrations. The findings of Antognozzi *et al. (*1995) and Duane (1996) proved that, CPPU increased fruit firmness of apple and olive fruits.

**Fruit weight**

Data in Tables ( 7 and 8 ) indicate that CPPU resulted in the highest fruit weight in the two seasons of study. Fruit weight increased as CPPU concentration increased.. These results were supported by Reynolds *et al. (*1992) and Antognozzi *et al. (*1993).

In this regard $KNo_3$ resulted in higher values than Putrescine. Oosthuyse (1993) mentioned that fruit weight of mango cv. Tommy Atkins was increased by 4% $KNo_3$ application. Fruit weight decreased sharply with increasing Putrescine and $KNo_3$ concentrations. The results of Ebrahiem *et al. (*1993) and Erner *et al. (*1993) are in agreement with our findings.

**Fruit length:**

Fruit length was longer with CPPU and $KNo_3$ treatments, while it was shorter with Putrescine. Fruit length was decreased by increasing $KNo_3$ and Putrescine concentration, while it was increased with the increase of CPPU concentration ( Tables 7 and 8 ).

**Fruit diameter**

Post set spray application of Putrescine, CPPU or $KNo_3$ increased fruit diameter in the two seasons of the study although it showed significant only in the second season. The highest increase in fruit diameter was recorded with CPPU treatment, However, differences were not obvious between the other tested substances. Fruit diameter decreased by increasing Putrescine and $KNo_3$ concentrations. On the other hand, the diameter increased markedly by increasing the concentration of CPPU (Tables 7 and 8).

**Fruit length / Diameter ratio (L/D)**

Post set spray of $KNo_3$, Putrescine and CPPU did not affect significantly fruit L/D ratio. (Tables 7 and 8).Bangerth and Schroder(1994) found that CPPU increased fruit length to diameter ratio L/D of apple fruits cv. Golden delicious and Jonagold.

**Fruit width**

Data in Tables (7 and 8) show that CPPU resulted in the highest fruit width followed by $KNo_3$. On the other hand, the lowest was scored with Putrescine. Generally, fruit width decreased with increasing the concentration

were insignificant. However, CPPU decreased total soluble solids. Moreover, of Putrescine and $KNo_3$. Reverseibly fruit width increased markedly by increasing the concentration of CPPU.

**Fruit Chemical Characters**

**Total soluble solids (TSS%)**

Data in Table (9) show that spraying Putrescine or $KNo_3$ significantly increased total soluble solids, the differences between Putrescine and $KNo_3$ differences were significant in the second season. Bhuyan and Irabagon (1992) support these results with mango cv. Carabao.

The highest concentration of Putrescine ( 450 PPM )resulted in the highest significant increase in TSS%. The same trend was observed with $KNo_3$. Bhuyan and Irabagon (1992) reported that spraying mango cv. Carabao with $KNo_3$ at 20 g/liter resulted in the highest values of total soluble solids in the fruit at harvest.

A negative association was observed between the concentration of CPPU and TSS content, as the lowest percentage of total soluble solids was recorded with the highest concentration of 15 PPM during the two seasons. Findings of Duane (1995) confirmed this result. On the other hand, Duane (1996) cleared that spraying apple cv. McIntosh with CPPU 19 days after full bloom, did not affect total soluble solids.

**Acidity**

Putrescine or CPPU post-set spray was significantly increased fruit acidity. On the other hand, fruit acidity was decreased insignificantly by $KNo_3$.These results are in line with those reported by Reynolds *et al*. (1992) as CPPU at 1 or 10 mg/liter increased juice acidity of grape berries.

The lowest concentration of Putrescine, (150 PPM) increased fruit acidity more than 300 or 450 PPM. Moreover, the lowest concentration of $KNo_3$ (0.5 %) gave the highest content. Findings of Erner *et al. (*1993) disagree with the obtained results, as $KNo_3$ at 5 % increased juice acidity of Shamouti and Valencia oranges.

The tabulated results, in Table (9) show a direct relationship between fruit acidity at harvest and CPPU concentration. Reynolds *et al. (*1992) supported these results. On the other hand the findings of Eric (1993) are on contrary with the obtained results, as he found that spraying CPPU at 5, 10, 15 or 20 mg/liter at full bloom or 2 weeks later, did not affect fruit acidity of apple cv. Delicious.

**TSS/ acid ratio**

Data in Table (9) indicate that CPPU treatments significantly decreased TSS/acid ratio than both of Putrescine and $KNo_3$ as well as the control. Conversely, both of Putrescine and $KNo_3$ have increased TSS/ acid ratio. A direct relationship was found between both of TSS/acid ratio and the concentrations of Putrescine and $KNo_3$.However, the highest values were recorded with the highest concentration. An opposite relationship was noted

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between the concentration of CPPU and TSS/acid ratio. These results are in line with those reported by Joublan *et al. (* 1995). Similarly, Reynolds *et al. (*1992) stated that CPPU reduced total soluble solids and increased fruit acidity of grape.

**Vitamin C**

Data in Table (9) show that post-set application of $KNo_3$ significantly increased vitamin "C" content of Alphonso mango fruit at harvest comparing with the other two tested substances or the control. However, the application of both Putrescine or CPPU insignificantly was affected fruit vitamin "C" content. The obtained results revealed that the highest vitamin "C" content (43.16 and 53.03 mg/100g FW) was recorded with $KNo_3$ at 2% during the two seasons of study respectively. Contrarily, the lowest content was recorded with spraying CPPU at 15 PPM. However, Ebrahiem *et al. (*1993) reported that $KNo_3$ increased vitamin "C" content of mandarin fruits.

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## تأثير معاملات الرش بعد العقد بالبيتروسين ونترات البوتاسيوم والسيتوفكس على عدد الثمار، معدل التساقط، نسبة الثمار المتبقية وجودة ثمار المانجو الفونس

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أجريت هذه الدراسة على أشجار مانجو الفونس عمرها 20 سنة. تم رش النورات بعد العقد بأسبوعين بكلا من البيتروسين بتركيز 150، 300 أو 450 جزء فى المليون، نترات البوتاسيوم بتركيز 5, ، 1 أو 2%، السيتوفكس بتركيز 5، 10 أو 15 جزء فى المليون. أوضحت النتائج أن كلا من البيتروسين ونترات البوتاسيوم أعطت زيادة معنوية فى عدد الثمار لكل نورة مقارنة بالكنترول وكانت هناك علاقة طردية بين التركيز وعدد الثمار. سجلت أقل قيم لمعدل التساقط مع البيتروسين يليها نترات البوتاسيوم والسيتوفكس. معاملات البيتروسين أدت إلى زيادة نسبة الثمار المتبقية معنويا عند الحصاد مقارنة بالمعاملات الأخرى. معاملات السيتوفكس أدت إلى زيادة صلابة الثمار، وزن الثمار، طول الثمار، قطر الثمار، عرض الثمار. معاملات البيتروسين ونترات البوتاسيوم أدت إلى زيادة المواد الصلبة الذائبة عن الكنترول فى حين وجدت علاقة عكسية بين تركيز السيتوفكس والمواد الصلبة الذائبة الكلية. حموضة الثمار زادت مع السيتوفكس والبيتروسين بينما قلت مع نترات البوتاسيوم.زادت نسبة المواد الصلبة الذائبة إلى الحموضة مع البيتروسين ونترات البوتاسيوم. أعلى قيمة لفيتامين "ج" سجلت مع نترات البوتاسيوم بتركيز 2% وأقل قيمة سجلت مع السيتوفكس بتركيز 15جزء فى المليون.

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**Table (1): Effect of post set spray of putrescine , $KNo_3$ and CPPU on number of fruits per panicle (season 1997).**

| Age of Fruit (days ) | Substances | | | | | | | | | CONTROL | MEAN ( C ) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PUTRESCINE | | | POTASSIUM NITRATE | | | CPPU | | | | |
| | 150PPM | 300PPM | 450PPM | .50 % | 1 % | 2 % | 5 PPM | 10PPM | 15PPM | | |
| 15 | 12.30 | 13.3 | 12.9 | 12.96 | 12.40 | 13.00 | 12.20 | 12.70 | 12.90 | 12.86 | 12.75 |
| 30 | 6.83 | 8.03 | 8.33 | 7.76 | 8.20 | 9.10 | 7.80 | 4.40 | 2.60 | 4.40 | 6.74 |
| 45 | 2.31 | 3.13 | 4.93 | 4.50 | 4.70 | 4.73 | 4.46 | 2.40 | 2.00 | 3.33 | 3.64 |
| 60 | 1.86 | 2.63 | 3.60 | 2.36 | 2.13 | 3.66 | 2.13 | 1.80 | 1.50 | 1.93 | 2.36 |
| 75 | 1.51 | 1.66 | 2.36 | 2.20 | 2.00 | 2.96 | 1.16 | 0.96 | 1.16 | 1.10 | 1.7 |
| 90 | 1.37 | 1.56 | 2.26 | 1.46 | 1.53 | 2.20 | 1.03 | 0.93 | 0.90 | 1.00 | 1.42 |
| 105 | 1.33 | 1.43 | 2.20 | 1.23 | 1.43 | 2.10 | 0.96 | 0.90 | 0.76 | 0.76 | 1.31 |
| 120 | 1.32 | 1.40 | 2.16 | 1.20 | 1.40 | 1.93 | 0.86 | 0.80 | 073 | 0.70 | 1.11 |
| MEAN(A) | 3.60 | 4.19 | 4.84 | 4.20 | 4.22 | 4.92 | 3.82 | 3.11 | 2.73 | 3.26 | |
| MEAN(B) | 4.14 | | | 4.44 | | | 3.22 | | | 3.26 | 7.8 |

**LSD at 5% for : Concentrations (A) = 0.3481 Substances (B) = 0.2010 Age of fruit (C ) = 0.2842 A x B x C = 0.9845**

**Table (2): Effect of post set spray of Putrescine , $KNo_3$ and CPPU on number of fruits per panicle (season 1998).**

| Age of Fruit (days ) | Substances | | | | | | | | | CONTROL | MEAN ( C) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PUTRESCINE | | | POTASSIUM NITRATE | | | CPPU | | | | |
| | 150PPM | 300PPM | 450PPM | 0.50 % | 1 % | 2 % | 5 PPM | 10PPM | 15PPM | | |
| 15 | 15.00 | 16.20 | 11.30 | 13.40 | 16.20 | 13.70 | 12.80 | 14.60 | 10.06 | 13.8 | 13.76 |
| 30 | 4.50 | 6.60 | 7.60 | 6.80 | 7.90 | 7.80 | 5. 60 | 5.06 | 7.70 | 5.3 | 6.48 |
| 45 | 2.80 | 4.10 | 5.20 | 3.10 | 3.40 | 5.30 | 2.70 | 2.06 | 3.06 | 2.4 | 3.41 |
| 60 | 2.33 | 2.13 | 2.96 | 2.20 | 2.60 | 3.30 | 1.70 | 1.73 | 1.46 | 1.06 | 2.14 |
| 75 | 1.73 | 2.06 | 2.60 | 1.80 | 2.00 | 2.10 | 1.50 | 1.30 | 1.30 | 0.76 | 1.71 |
| 90 | 1.70 | 1.90 | 2.50 | 1.50 | 1.90 | 2.06 | 1.46 | 1.23 | 1.23 | 070 | 1.61 |
| 105 | 1.66 | 1.83 | 2.46 | 1.33 | 1.86 | 1.96 | 1.43 | 1.16 | 1.13 | 0.66 | 1.54 |
| 120 | 1.63 | 1.80 | 2.40 | 1.23 | 1.83 | 1.93 | 1.40 | 1.13 | 0.96 | 0.63 | 1.49 |
| MEAN(A) | 3.91 | 4.57 | 4.62 | 3.92 | 4.71 | 4.76 | 3.57 | 3.53 | 3.43 | 3.16 | |
| MEAN(B) | 4.36 | | | 4.46 | | | 3.51 | | | 3.16 | |

**LSD at 5% for : Concentrations (A) = 0.6850 Substances (B) = 0.3955 Age of fruit (C ) = 0.5593 A x B x C = 1.937**

**Table (5): Effect of post set spray of Putrescine , $KNo_3$ and CPPU on rate of fruit drop (season 1997).**

| Age of Fruit (days ) | Substances | | | | | | | | | CONTROL | MEAN (C ) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PUTRESCINE | | | POTASSIUM NITRATE | | | CPPU | | | | |
| | 150PPM | 300PPM | 450PPM | 0.50 % | 1 % | 2 % | 5 PPM | 10PPM | 15PPM | | |
| 30 | 44.36 | 38.02 | 35.56 | 40.14 | 26.03 | 29.99 | 36.21 | 64.57 | 97.87 | 65.71 | 47.84 |
| 45 | 65.91 | 61.05 | 39.09 | 41.43 | 42.63 | 47.93 | 42.80 | 45.61 | 20.63 | 22.53 | 42.96 |
| 60 | 18.85 | 16.48 | 29.03 | 46.97 | 54.12 | 21.51 | 52.17 | 22.96 | 25.00 | 41.89 | 32.89 |
| 75 | 18.56 | 35.70 | 35.11 | 6.94 | 5.93 | 19.99 | 45.00 | 45.76 | 22.44 | 43.14 | 27.85 |
| 90 | 8.27 | 5.88 | 2.77 | 30.66 | 23.33 | 23.88 | 11.36 | 7.03 | 19.91 | 8.58 | 14.16 |
| 105 | 3.25 | 7.84 | 2.62 | 13.17 | 6.66 | 3.84 | 6.06 | 3.70 | 16.66 | 23.58 | 8.71 |
| 120 | 0.20 | 2.22 | 1.04 | 2.22 | 2.77 | 7.68 | 10.37 | 6.66 | 4.16 | 8.33 | 4.56 |
| MEAN(A) | 22.77 | 23.88 | 20.74 | 25.93 | 23.06 | 22.11 | 29.13 | 28.04 | 29.52 | 30.50 | |
| MEAN(B) | 22.46 | | | 23.70 | | | 28.89 | | | 30.50 | |

**LSD at 5% for : Concentrations (A) = 5.3335 & Substances (B) = 3.08 & Age of fruit (C ) = 4.075 & A x B x C = 14.12**

**Table (6): Effect of post set spray of Putrescine , $KNo_3$ and CPPU on rate of fruit drop (season 1998).**

| Age of Fruit (days ) | Substances | | | | | | | | | CONTROL | MEAN (C ) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PUTRESCINE | | | POTASSIUM NITRATE | | | CPPU | | | | |
| | 150PPM | 300PPM | 450PPM | 0.50 % | 1 % | 2 % | 5 PPM | 10PPM | 15PPM | | |
| 30 | 38.21 | 59.30 | 70.36 | 50.85 | 51.42 | 42.49 | 056.8 | 65.75 | 26.79 | 60.01 | 52.19 |
| 45 | 37.09 | 42.62 | 36.2 | 45.21 | 55.27 | 31.55 | 46.38 | 55.23 | 52.96 | 51.61 | 45.41 |
| 60 | 43.17 | 42.53 | 14.26 | 28.05 | 21.70 | 33.33 | 36.10 | 14.31 | 43.21 | 38.20 | 31.48 |
| 75 | 11.57 | 3.03 | 27.22 | 18.93 | 24.97 | 36.92 | 14.14 | 24.52 | 8.28 | 28.33 | 19.79 |
| 90 | 3.03 | 5.55 | 5.55 | 15.97 | 5.00 | 1.51 | 3.33 | 4.44 | 5.00 | 7.40 | 45.67 |
| 105 | 2.53 | 3.00 | 1.33 | 11.11 | 1.66 | 4.84 | 1.33 | 5.34 | 5.88 | 4.16 | 4.11 |
| 120 | 2.64 | 1.75 | 1.38 | 7.00 | 1.75 | 1.66 | 0.00 | 2.77 | 12.85 | 4.16 | 3.59 |
| MEAN(A) | 19.74 | 22.54 | 22.32 | 25.30 | 23.11 | 21.75 | 22.58 | 24.62 | 20.56 | 27.69 | |
| MEAN(B) | 21.53 | | | 23.38 | | | 22.58 | | | 27.69 | |

**LSD at 5% for : Concentrations (A) = 6.88 & Substances (B) = 3.97 & Age of fruit (C ) = 5.26 & A x B x C = 18.22**

**Table (7): Effect of post set spray of putrescine, $KNo_3$ and CPPU on fruit Physical characters at harvest (season 1997)**

| Substances | Conc. | Fruit characters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fruit firmness Kg/ $cm^2$ | Average | Fruit weight (G) | Average | Fruit length (cm) | Average | Fruit diameter (cm) | Average | L/D ratio | Average | Fruit Width (cm) | Average |
| Putrescine | 150 PPM | 1.90 | 1.93 | 355.00 | 324.33 | 9.63 | 9.43 | 7.53 | 7.37 | 1.27 | 1.27 | 8.50 | 8.21 |
| | 300 PPM | 1.93 | | 310.33 | | 9.50 | | 7.30 | | 1.30 | | 8.33 | |
| | 450 PPM | 1.96 | | 307.66 | | 9.16 | | 7.30 | | 1.25 | | 7.80 | |
| CPPU | 5 PPM | 2.53 | 2.76 | 309.66 | 343.55 | 9.90 | 9.94 | 7.03 | 7.49 | 1.40 | 1.32 | 8.00 | 8.40 |
| | 10 PPM | 2.86 | | 349.66 | | 9.93 | | 7.60 | | 1.30 | | 8.40 | |
| | 15 PPM | 2.90 | | 371.33 | | 10.00 | | 7.86 | | 1.27 | | 8.80 | |
| $KNo_3$ | 0.5 % | 2.43 | 2.74 | 351.66 | 331.94 | 10.13 | 10.01 | 7.50 | 7.38 | 1.35 | 1.35 | 8.50 | 8.24 |
| | 1 % | 2.83 | | 327.16 | | 10.06 | | 7.33 | | 1.37 | | 8.16 | |
| | 2 % | 2.96 | | 317.00 | | 9.86 | | 7.33 | | 1.34 | | 8.06 | |
| Control | 2.00 | 2.00 | 319.20 | 319.20 | 9.56 | 9.56 | 7.13 | 7.13 | 1.33 | 1.33 | 8.10 | 8.10 | |
| LSD at 0.05 | 0.119 | 0.069 | 61.24 | N. S. | N. S. | N. S. | N. S. | N. S. | N. S. | N. S. | 0.93 | N. S. | |

**Table (8): Effect of post set spray of putrescine, $KNo_3$ and CPPU on fruit Physical characters at harvest (season 1998)**

| Substances | Conc. | Fruit characters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fruit firmness Kg/ $cm^2$ | Average | Fruit weight (G) | Average | Fruit length (cm) | Average | Fruit diameter (cm) | Average | L/D ratio | Average | Fruit Width (cm) | Average |
| Putrescine | 150 PPM | 1.93 | 1.99 | 331.06 | 319.59 | 9.63 | 9.66 | 7.73 | 7.38 | 1.24 | 1.30 | 8.20 | 8.15 |
| | 300 PPM | 2.00 | | 313.76 | | 9.86 | | 7.33 | | 1.34 | | 8.20 | |
| | 450 PPM | 2.06 | | 313.96 | | 9.50 | | 7.10 | | 1.33 | | 8.06 | |
| CPPU | 5 PPM | 2.40 | 2.64 | 316.00 | 347.95 | 9.76 | 10.04 | 7.26 | 7.64 | 1.34 | 1.30 | 8.33 | 8.67 |
| | 10 PPM | 2.60 | | 353.10 | | 10.06 | | 7.60 | | 1.31 | | 8.66 | |
| | 15 PPM | 2.93 | | 374.76 | | 10.30 | | 8.06 | | 1.27 | | 9.03 | |
| $KNo_3$ | 0.5 % | 2.36 | 2.57 | 356.63 | 336.09 | 10.30 | 10.00 | 7.63 | 7.45 | 1.35 | 1.33 | 8.46 | 8.35 |
| | 1 % | 2.46 | | 331.50 | | 9.96 | | 7.43 | | 1.33 | | 8.33 | |
| | 2 % | 2.90 | | 320.16 | | 9.70 | | 7.30 | | 1.33 | | 8.24 | |
| **Control** | | 1.96 | 1.96 | 319.66 | 319.66 | 9.10 | 9.10 | 7.00 | 7.00 | 1.30 | 1.30 | 8.10 | 8.10 |
| **LSD at 0.05** | | 0.169 | 0.097 | N. S | N. S. | 1.09 | 0.629 | 0.612 | 0.353 | N. S. | N. S. | 0.90 | 0.52 |