J.Agric.&Env.Sci.Alex.Univ.,Egypt Vol.6 (1)2007

EFFECT OF ETHREL ON FLORAL INDUCTION IN YOUNG TREES OF THREE COMMERCIAL MANGO CULTIVARS.

KARIM M. FARAG[1], EMAN M SHOKRY[2], AND AHMED S. EL-SABAGH[1].

[1] Department of Horticuture, (Pomology), Faculty of Agriculture, Damanhour Branch, University of Alexandria,P.O.Box 22516, Damanhour, Egypt.
[2] Department of Food Supply, Ministry of Social Solidarity, Damanhour, Egypt.

ABSTRACT

This study was conducted during the two consecutive seasons 2003 and 2004 by using three commercial cultivars of young mango trees, namely Ewaise, Zebda and Alfonse grown in pots in the open field. The study aimed at determining the effect of Ethrel (or ethephon) on floral induction of young mango trees, correlating some nutritional factors to ethylene in terms of their influence on floral induction, and finding out a safe mean of manipulating flowering of mango trees. The treatments included the use of Ethrel (48% of stock solution) at 0.5%, 1% and 1.5% (V/V) in addition to the control. Trees were sprayed to the run off during the period prior to the floral induction. Spray was done twice in the last week of November and at the middle of December in both seasons. The completely randomized block design was used where each treatment was replicated four times and each tree represented one replication. Applied Ethrel concentrations were effective in floral induction in young mango trees of the three used cultivars while in the control plants there was no floral induction. Ethrel at 1% resulted in significantly greater number of panicles as compared with Ethrel at 0.5% or 1.5%. The panicle length increased as the concentration of Ethrel increased. All used Ethrel concentrations were not effective in increasing leaf area when compared with the control in

both seasons. Ethrel spray at 0.5% and 1% caused a significant increase in fresh weight of the vegetative growth when compared with the control. Among used Ethrel concentrations, Ethrel at 1.5% was the most effective in increasing such weight. In case of the dry weight of the vegetative growth, the trend of results was similar to that obtained with the fresh weight where the highest dry weight was obtained with Ethrel at 1.5%. Ethrel spray at 1.5% caused a significant increase in the fresh weight of the root system in the three used cultivars as compared with Ethrel spray at 0.5%, 1% or the control. Similar trend of results was obtained with the dry weight of the root system since Ethrel at 1.5% gave the highest dry weight of the root system in the three cultivars. Ethrel spray at all used concentrations led to a significant increase in nitrogen content in the leaves as compared with the control while there was no significant difference among the three Ethrel concentrations in terms of their nitrogen content. There was a negative relationship between Ethrel concentration and phosphorus content in the leaves. Ethrel increased the ability of leaves to accumulate more potassium when compared with the control. As the used Ethrel concentration increased, there was a parallel increase in total carbohydrate in the leaves of the three cultivars. It was found that the ability of Ethrel to induce flowering in young mango trees did not correlate to the C/N ratio in the leaves. As for the cultivar effect, it was found that the three used cultivars did not significantly vary in the number of formed panicles. This trend was consistent in both seasons. The thickness of the panicle at the base in Ewaise was greater than that found in Zebda which in turn was greater than that of Alfonse. The panicle length in Alfonse was greater than that found in Ewaise and Zebda. The leaf area values of Ewaise and Zebda were larger than that found in Alfonse in both seasons. According to the analysis of the interaction between the treatments and cultivars, it could be recommended to spray Ethrel on Ewaise at 0.5% and to spray Ethrel at 1% on Zebda and Alphonse to induce flowering.

J.Agric.&Env.Sci.Alex.Univ.,Egypt Vol.6 (1)2007

INTRODUCTION

Mango is one of the most popular fruit in the world. Mangoes are now widely available as fresh fruit and in the form of frozen and processed products, not only in the tropics and subtropics but also year round in North America, Japan and Europe. The latest available statistics estimated the production of mangoes in Egypt to be 380,000 metric tons (FAO, 2005) planted in 35000 hictar (84296 feddans) in many regions of Egypt. The last few years have witnessed a massive and impressive increase in mango production due to its exportation into new growing regions. Since flowering and fruit set are the most critical events that occur after establishment of a tree crop, it is very important to control and manipulate the timing and intensity of flowering. In relatively young mango trees, the load of panicles determines the yield of fruits. Understanding and manipulating flowering has been the prime interest of scientists all over the world. The main problem is the lack of basic information on the flowering process. There have been tremendous efforts to elucidate the mechanism of flowering, but obtained information still controversial . Understanding the basic factors affecting flowering would benefit mango producers in terms of extending both the flowering and crop production season. Several new approaches to the study of mango flowering have been made in recent years (Chacko, 1991; Cull, 1991; Kulkani, 1991; Whiley *et al.*, 1991 and Daverport, 1993). Several factors have been involved in floral induction of mangoes. These factors were classified into environmental, hormonal, or nutritional. Ethylene has been considered as one of the hormonal factors that influence mango flowering (Davenport and Núñez-Elisea, 1990). The involvement of ethylene in inducing flowering of mango trees was early observed during the twentieth of the last century when Wester (1920) and Gonzales (1923) found that the exposure of such trees to smoke from burning leaves stimulated the flowering of mango in Philippines. This conclusion was further supported by other scientists (Pantastico and Manuel, 1978). However, a certain period of the plant age was found to be important to respond to smudging which was called "ripeness. This finding was coupled with the first successful use of ethephon (Barba, 1974) and others (Bondad, 1972, 1976). Available information led to the hypothesis that endogenous ethylene plays an integral role in the floral inductive process (Chadha and Pal, 1986). Numerous studies provided further evidences about the role of ethylene on floral induction and promotion in various mango cultivars (Núñez-Elisea *et al.*, 1979; Rath and Das, 1979; Chen, 1985 and Das

et al., 1989). Inconsistent with the above studies, several other investigations reached to non-responsive results after using ethephon spray on mango trees especially during warm non-inductive conditions (Pandey *et al.*, 1973; Sen *et al.*, 1973; Winston and Wright, 1986). Davenbort and Núñez-Elisea (1990, 1991) reported elevated ethylene production in mango shoot in response to ethephon sprays without an accompanying floral response. Experiments were conducted during both floral-inductive and non-inductive periods. In contrast to Saidha *et al.*, (1983), they observed no increase in ethylene production rates prior to or during panicle development. Aforementioned revealed the importance of studying the role of the ethylene-releasing compound on floral induction of three important Egyptian cultivars of mango. Thus, the objectives of this study were: To determine the effect of Ethrel (or ethephon) on floral induction of young mango trees. To correlate the nutritional factors to ethylene in terms of their influence on floral induction, and to find out a safe mean of manipulating flowering of mango trees.

MATERIALS AND METHODS

This study was conducted during the two successive seasons 2003 and 2004 using young mango trees which were 3 years old, healthy, Juvenile, uniform and free of defects. Three commercial mango cultivars were used, namely Zebda, Alphonse and Ewaise. Plants were grown in pots (60 cm diameter) in a sandy soil and were maintained in open field near Damanhour, Behera governorate. Trees were reproduced through vegetative propagation and were under standard cultural practices in terms of plant protection, irrigation, pruning and fertilization. Trees were treated by Ethrel (2-chloroethyl phosphonic acid) by spraying twice. The first spray was done at the last week of November while the second was at the middle of December in both seasons of the study. These application times considered with the period before floral induction as determined by Zidan *et al.* (1975). Treatments included: Ethrel at 0.5, 1 or 1.5% (volume to volume) of the stock solution (48%) in addition to the control (sprayed with water). The surfactant Tween 20 was added at 0.05% v/v. Five mature leaves were randomly sampled from various parts of the lateral shoots at the initiation of the flowering (at the end of February) in each season for the determination of nitrogen, phosphorus, potassium and

total carbohydrates according to Association of Analytical Chemists (A.O.A.C., 1983). Quantitative assessment of such elements was carried out by using automated atomic absorption apparatus. Total nitrogen (based on crude protein) percentage was determined by using the macro-Kjeldahl method (Block apparatus digester). Crude protein percentage was determined also by using A.O.A.C. (1983). Leaf area was determined by using the equation of Ahmed and Morsy (1999). All physical or chemical assays were carried out in triplicates. Assessment of floral induction was done by tagging lateral shoots on each young tree where the number of panicles, panicle length (cm), panicle thickness at the base and number of flowering panicles was surveyed. By the end of sampling, in the second season the fresh weight and dry weight of the canopy (vegetative growth) and the root system were determined. The completely randomized block design was used where each treatment was replicated four times. Each tree represented one replication. Statistical analysis was accomplished by using Costat computer software to obtain the analysis of variance (ANOVA). Treatment mean comparison was done by using the least significant difference (LSD) at 0.05 level by using the same software.

RESULTS AND DISCUSSION

I. The Treatment Factor:

1. Floral induction and some panicle characteristics:

The data in Table 1 indicated to the effect of various treatments, regardless the cultivars on floral induction and some panicle characteristics. The data revealed that all used concentrations of Ethrel were significantly effective in induction of flowering as compared with the control, which resulted in no floral induction in the three mango cultivars Ewaise, Zebda and Alphonse. However, Ethrel at 1% resulted in significantly higher number of panicles as compared with Ethrel at 0.5% or 1.5%. These trends were consistent during both seasons of the study except 1.5% in the second season. Moreover, Ethrel at 0.5 and 1.5% were equally effective in floral induction except with Ethrel at 1.5% in the second season that caused the formation of floral panicles similar to that found with Ethrel at 1.0%.

With regard to the thickness of the rachis at the base, it was found that Ethrel at 1.5% was more effective in increasing such thickness as compared with Ethrel at either 0.5 or 1% in both seasons. Since there was no floral induction in the control plants, no measurements were taken or reported for the control in Table 1. The general trend in this character was an increase in the thickness of the rachis as the concentration of Ethrel was increased. In a similar way, Ethrel was effective in increasing the length of panicles of various mango cultivars. The results showed that a general trend of increasing panicle length as the concentration of Ethrel was increased. Ethrel at 1.5% resulted in significantly longer panicle as compared with Ethrel at 0.5%. However, the length of panicle as compared with Ethrel at 0.1% did not consistently vary from such length obtained with either Ethrel at 0.5% or 1.5%. Again, no data were reported for the control in this character since no floral induction occurred (Table 1).

The reported results of floral induction as results of Ethrel treatments to mango trees agreed with Chacko *et al.*, (1972 a,b); Rath and Das (1979); Rabelo *et al.*, (1999) who accelerated flowering and fruiting of mango with Ethrel treatments. Moreover, Das *et al.*, (1989) concluded that Ethrel can be used to overcome the alternate bearing habit of mango cultivar Langra. Furthermore, Shaban (2004) found that Ethrel significantly increased flowering as compared with the control. Regarding panicle length and thickness, these results were in agreement with findings of Maiti and Sen (1989), Maiti *et al.*, (1971), Galila and El-Masry (1991), Mukhopadhaya (1976); El-Beltagy *et al.*, (1979) and Ebeed (1989) when they applied Ethrel to mango trees, there was an increase in the total number of panicles and the size of panicles.

2. Leaf area canopy and root system characteristics:

The effect of various Ethrel treatments on leaf area of various young mango trees, regardless of the cultivars, was shown in Table 2. The data indicated that Ethrel at all used concentrations did not result in a significant increase in leaf area as compared with the control in both seasons. In the meantime, no significant difference in leaf area was found among the three used Ethrel concentrations. This trend was consistent in both seasons, of the study.

Fresh weight of the vegetative growth was significantly affected by various Ethrel concentrations regardless the used cultivar.

The data in Table 2 showed that there was a significant increase in the fresh weight of the vegetative growth caused by Ethrel at 0.5 and 1% as compared with the control. Meanwhile, there was no significant difference between the weight of the vegetative growth (canopy) when Ethrel at 0.5% and 1% were compared.

Moreover, the use of Ethrel at 1.5% resulted in a significant increase in the weight of vegetative growth when compared with either the control or the two other Ethrel concentrations, 0.5 and 1% during 2004 season.

In a simple manner, results of dry weight of the vegetative growth took a similar trend to that obtained with the fresh weight of the vegetative growth. Again, all used Ethrel concentrations had a significant effect on such weight when compared with the control. The superior effect on dry weight of the vegetative growth was again obtained with the highest used Ethrel concentration (1.5%). The influence of Ethrel spray on the dry weight of the vegetative growth was really drastic as was shown in Table 2. For example, Ethrel at 1.5% resulted in twice as such dry weight of the vegetative growth as that obtained with the control.

With regard to the fresh weight of the root system as influenced by the treatments, it was found that Ethrel at either 0.5 or 1.0% did not result in a significant increase the character when compared with the control.

However, there was a general trend of greater fresh weight of the root system as the Ethrel concentration increased. Moreover, Ethrel at 1.5% caused a significant increase in the fresh weight of the root system as compared with all the other treatments and the control. Typical trend of result was obtained with the dry weight of the root system resulting from other Ethrel treatments. Again, the significant increase in such studied character was found with Ethrel at 1.5% regardless of the cultivar.

Dry weight of the root system was increasing in proportional to the used Ethrel concentration. The lowest value of root dry weight was gained with the control trees (Table 2). These results did not agree with Das *et al.*, (1988) who reported that the application of GA or urea or Ethrel or in combination leading to increase leaf area, leaf number and shoot length in both "off" and "on" years shoots buds.

This increase was attributed to the addition of GA or urea prior to the spray of Ethrel.

3. Some Macro – nutrients, total carbohydrates and proteins:

Percentage of nitrogen in the leaf was significantly influenced by Ethrel treatments regardless of the sprayed cultivar (Table 3). The data indicated that Ethrel at various concentrations resulted in a significant increase in nitrogen content when compared with the control. Meanwhile, there was no significant difference among all used Ethrel concentrations in terms of their influence on nitrogen accumulation in the leaf.

Percentage of phosphorus in the leaf was also affected by Ethrel treatments (Table 3). The data indicated that Ethrel at 0.5% resulted in a significant increase in phosphorus content as compared with the control. However, Ethrel at 1% and 1.5% led to lower phosphorus content than the control and Ethrel at 0.5%. As the concentration of Ethrel increased, the accumulation of phosphorus decreased significantly. The lowest percentage of phosphorus was obtained with Ethrel at 1.5%

Potassium content data in the leaves as influenced by various Ethrel treatments are shown in Table 3. The data revealed that potassium increased in the leaves as the sprayed Ethrel concentration increased. The highest potassium content was obtained with Ethrel at 1.5%. All Ethrel concentrations led to a significant increase in potassium as compared with the control. The lowest percentage of potassium in the leaves was found in the control. Thus, Ethrel spray increased the ability of mango leaves to accumulate more potassium relative to the control.

With regard to total carbohydrates in the leaves as influenced by various Ethrel concentrations regardless the cultivar (Table 3), the results indicated that Ethrel-treated leaves had significantly higher amount of carbohydrates than that found in the control leaves. Furthermore, the higher concentration of Ethrel gave the greater amount of carbohydrates in leaves. Thus, Ethrel at 1.5% led to loading more carbohydrates in the leaves than that occurred by Ethrel at 1.0 or 0.5%. However, there was no significant difference between the total carbohydrates in the leaves of the control and Ethrel-treated plants at 0.5%.

The effect of various Ethrel concentrations on the C/N Ratio in the leaves of young mango trees was calculated from the data of percentage of nitrogen and that of total carbohydrates. The data indicated that there was no significant difference among Ethrel-treated plants in terms of their C/N ratio. Even the control plants did not show any significant difference from all Ethrel treatments. Thus, it appeared that the variations in the ability to induce flowering in young mango trees did not correlate to the ratio of carbohydrates to nitrogen in such woody plants.

Percentage of protein was also influenced by various Ethrel treatments, regardless the variations in the cultivars. The data in Table 3 provided evidence that there was a significant increase protein content in the leaves as a result of Ethrel treatments. As the Ethrel concentration increased, the percentage of proteins also increased compared with the control during 2004 season. However, no significant difference was found in the percentage of proteins when comparing the effect at 1.0% and 1.5%.

The above results agreed with Shaban (2004) who indicated to an increase in total carbohydrates, nitrogen, phosphorus and potassium as a result of Ethrel treatment to young mango trees.. Even amino acids had an increase with spraying Ethrel.

However, Surayanarayana (1980 b) found a pronounced decrease in amino acids content at flower bud formation in mango. Avilan, (1971) reported that leaves of mango cultivar Kent showed highest minerals contents before flowering, and then it was fell during flowering and fruit formation.

Obtained results were in line with Sanyal and Mitra, (1999), as they concluded that leaves and shoot phosphorus and potassium contents may play some role in induction of flowering in mango cultivars Himsagar, Langra and Baramasia as phosphorus and potassium decreased gradually from October to December, however leaves in the off year contained lower amount of phosphorus and potassium than those in the on year. Shaban (2004) and Pandy *et al.*, (1973), Suryanarayana (1980a) reported that C/N ratio increased with application of Ethrel during the period of flower bud differentiation.

J.Agric.&Env.Sci.Alex.Univ.,Egypt Vol.6 (1)2007

II. The Cultivar Factor:

1. Floral induction and some panicle characteristics:

In terms of the effect of the variations in cultivar on floral induction, the data in Table 4 proved that the three used cultivars, namely Ewaise, Zebda and Alphonse did not vary in the number of panicles per plant. This trend was consistent during both seasons of study. Thus, variations in cultivars, in this study, did not contribute to the obtained number of panicles per plant.

However, variations in cultivars led to a significant variation in the thickness of rachis at the base of the panicle. As shown in Table 4, panicles of Ewaise were thicker at their base than Zebda panicles. However, thickness of the rachis at the base in Zebda panicle was still significantly greater than that of Alphonse. Thus, Alphonse panicle had the smallest thickness at the base in the studied cultivars.

The length of panicles was also affected by the variations in cultivars. It was found that Alphonse panicle was significantly longer than that of Ewaise and Zebda in both seasons. This might explain the reason for the smallest thickness of rachis at the base in Alphonse panicle. Moreover, the length of panicle in Ewaise and Zebda did not significantly vary in both seasons (Table 5).

2. Leaf Area and Some Characteristics of the Canopy and Root System:

The data in Table 5 demonstrated the effect of variations in cultivars on some vegetative and root characteristics. The data indicated that leaf area could be influenced by the cultivar factor. Leaf area of Ewaise and Zebda did not vary in both seasons. However, both Ewaise and Zebda leaves had significantly larger leaf area than that of Alphonse. These results were consistent in both seasons.

With regard to the fresh weight of the vegetative growth, it was found that Zebda and Alphonse had similar vegetative growth. However, Ewaise cultivar had significantly smaller weight of the vegetative growth than that found in Zebda and Alphonse. Even the dry weight of the vegetative growth of Ewaise cultivar tended to be smaller than that of Zebda and Alphonse but the difference was not significant (Table 5).

Fresh weight of the root system took a different trend from that found with the fresh weight of the vegetative growth. The results showed that there was no significant difference among the three used

cultivars in their fresh weight of the root system. In a similar manner, the data revealed that the dry weight of the root system did not significantly vary among the three cultivars. However, it was noticeable that either the fresh or dry weight of Zebda cultivar was relatively higher than that found with Ewaise and Alphonse cultivars.

The effect of variations in cultivars found in this study in terms of its effect on the leaf area or some characteristics of the canopy and root system agreed with the studies of Sharma (1999) on Dashehari and Langra mango Cultivars; and Ahmed (2002) on 20 cultivars included Ewaise, Zebda and Alphonse cultivars. They all observed great variations in the leaf area of studied cultivars

3. Some Macro-nutrients, Total Carbohydrates, and Proteins:

Nitrogen, phosphorus and potassium content in the leaves of the three used cultivars seemed to be affected by cultivar differences (Table 6). It was found that Alphonse leaves had significantly higher nitrogen content than Zebda and Ewaise.

Moreover, Ewaise leaves had significantly lower nitrogen content as compared with that found in Zebda leaves. Similar trend of results was found with phosphorus content in the leaf where Alphonse leaves again had significantly more phosphorus than Ewaise and Zebda leaves.

The smallest amount of phosphorus was obtained in Zebda leaves when compared with Ewaise and Alphonse leaves (Table 6).

The data in Table 6 indicated to the variations in potassium content in the leaf as influenced by various Ethrel concentrations. The data showed that Zebda and Alphonse leaves were able to accumulate significantly lower amount of potassium as compared with Ewaise. However, there was no significant difference between potassium content in the leaves of Zebda and Alphonse.

Percentage of total carbohydrates, however, was not influenced by the variations in cultivars since all the three cultivars did not significantly vary in their percentage of carbohydrates.

From the calculations, the data revealed that the C / N ratio significantly varied among the studied cultivars. Even though there was no significant difference between Zebda and Alphonse in such ratio. The C/N ratio in the leaves of Ewaise was significantly greater than that found in Zebda or Alphonse leaves. Since the percentage of total carbohydrates did not significantly vary among the three studied

cultivars, the main effect of the C / N ratio was attributed to the variations in nitrogen content among these three cultivars (Table 6).

Since the percentage of nitrogen in the three cultivars did not correlate to the leaf area or the dry weight of the vegetative growth and three cultivars did not significantly vary in the dry weight of the root system, it could be suggested that the variations among cultivars were genetically controlled. Furthermore, variations in C/N ratio between Ewaise as compared with Zebda and Alphonse did not suggest a critical role for such ratio since the three cultivars did not significantly vary in the number of panicles (Table 4).

III. The Interaction Between treatments and Cultivars:

Floral induction and some panicle characteristics as influenced by the interaction between treatments and cultivars were shown in Table 7. The data indicated that Ethrel treatment at 1% on Alphonse resulted in significantly higher panicle induction as compared with other treatments on other cultivars. The second positive interaction was obtained when Ethrel at 1.0% was applied to Zebda young mango trees. None of the control plants of any used cultivars was able to induce panicles. The effect of Ethrel at 1% on panicle induction in Ewaise trees was similar to the effect of Ethrel at 1.5% on panicle induction whether in Ewaise, Zebda or Alphonse. Moreover, Ethrel influence on panicle induction in Ewaise even at 0.5% did not significantly vary from the effect of the same compound but at 1.5% on Ewaise, Zebda or Alphonse. Thus, with regard to panicle induction, the best economic combination for Ewaise was Ethrel at 1.5 %, or Ethrel at 1.0% for Zebda and Alphonse (Table 7).

The effect of treatments and cultivars interaction on panicle length was also shown in Table 7. The data indicated that Ethrel at 0.5% resulted in significantly higher panicle length in Alphonse cultivar than that found with Ethrel at 0.5% in Ewaise and Zebda cultivars. The effectiveness of Ethrel at 0.5% on increasing panicle length was similar to that obtained with Ethrel at 1.0 and 1.5% in Alphonse. Moreover, it did not vary from that obtained with Ewaise and Zebda but at higher concentrations. Thus, with regard to panicle length, increasing Ethrel concentration to 1.5% did not result in added advantage in Ewaise, Zebda or Alphonse since the difference between 1% and 1.5% in panicle length was not significant. The data also indicated that the best efficacy was gained with Ethrel at 0.5% on

Alphonse while the lowest was gained with Ethrel at 0.5% on Ewaise and Zebda (Table 7).

Panicle thickness was also affected by the interaction between treatment and cultivar. It was shown that Ethrel at 0.5% resulted in similar panicle thickness to that found with Ethrel at 1% and 1.5% in Ewaise cultivar and did not significantly vary from panicle thickness in Zebda at 1% and 1.5%. Furthermore, panicle thickness at the base of the rachis with Ethrel at 0.5% was significantly higher than that found in Alphonse at all used Ethrel concentrations. In addition, Ethrel concentration increased when spraying Alphonse did not make any significant difference in terms of panicle thickness at the base of the rachis (Table 8).

The data in Table 9 indicate the interaction between treatments and cultivars and its effect on some characteristics of the shoot and root system of young mango trees. Fresh weight of the vegetative growth in the control of all cultivars did not significantly vary. Moreover, Ethrel at 1.5% applied to Ewaise resulted in a significant fresh weight of the vegetative growth when compared with the control. Similarly, such increase in weight in all Ethrel concentrations with Zebda and Alphonse was higher than that found in the control and Ewaise. Thus, the use of the lowest Ethrel concentration was as effective as the highest concentration in terms of its effects on such character.

With regard the fresh weight of the root system as influenced by the interaction between treatments and cultivars (Table 9), the data revealed that Ethrel at 0.5% caused the formation of a root system in Zebda that did not significantly vary from the fresh weight of the root system obtained with Ethrel at 1.5% in Ewaise and Alphonse. It was also clear that all Ethrel concentrations had the same effectiveness on the fresh weight of the root system only in the case of Zebda cultivar, however, in Ewaise as the concentration of Ethrel decreased, there was a significant reduction in the fresh weight of the root system while the control had the lowest weight. Similar situation was found in Alphonse where even Ethrel at 0.5% was significantly more effective than the control in such character. It was also found Ethrel treatment to young mango trees at all used concentrations were effective in increasing the fresh weight of the root system in all cultivars when compared with the control of each control.

The effect of the interaction between the treatments and cultivars on the dry weight of the vegetative growth was shown in Table 9. It was clear that Ethrel at 1.5% with Ewaise cultivar resulted in significantly greater weight than the control. However, reduced Ethrel concentrations of other cultivars such as Zebda and Alphonse were effective in increasing such characters. There was also a general trend of reduced dry weight of the vegetative growth in the control of the three cultivars. Moreover, no control was superior over the others in such character.

The dry weight of the root system was also influenced by the interaction between treatments and cultivars (Table 9). The data revealed that Zebda responded the most to Ethrel application in terms of the increase in such character. Even Ethrel at 0.5% in Zebda was as effective as Ethrel at 1.5% in Ewaise and Alphonse on increasing the dry weight of the root system. Moreover, such character values were similar when comparing Ethrel effect at 0.5% in the three cultivars. The dry weight of the root system in the control of Zebda was also greater than that of Ewaise and Alphonse. In general the responses of the root and shoot systems to Ethrel spray were not similar for various used cultivars.

Leaf area as influenced by the interaction between treatments and cultivar in both seasons was shown in Table 10. It was obvious that no combination between treatment and cultivar was superior in leaf area. Increasing Ethrel concentration to 1.5% did not make a difference when compared with the control of all cultivars in terms of the obtained leaf area. In all used cultivars, no one had the advantage of larger leaf area as a result of treatments by various Ethrel concentrations (Table 10). These above trends were consistent in both seasons of the study.

The effect of interaction between treatments and cultivars on some micro-nutrients, total carbohydrates and proteins was shown in Table 11. Ethrel at all used concentrations had a similar effect on nitrogen accumulation in the leaves when Ewaise and Zebda were compared. However, higher content of nitrogen was found in Alphonse leaves sprayed with Ethrel at 1.0 or 1.5% as compared with the two other cultivars at all concentrations. The concentration of Ethrel did not correlate to the content of nitrogen. The nitrogen content in Ewaise and Alphonse leaves was similar to that found in

Ethrel sprayed Ewaise trees with either 1.0% or 1.5%. No specific pattern could be concluded for the nitrogen content in the leaves of the three cultivars whether they were sampled from the control or Ethrel-treated plants.

Regarding the phosphorus content in leaves of the three cultivars as influenced by the interaction between treatments and cultivars, it was found that Ewaise and Alphonse had higher content of phosphorus when Ethrel at 0.5% was compared with other Ethrel concentrations in the three cultivars. Thus, Ethrel at relatively lower concentration (0.5%) was more effective than Ethrel-treated leaves at 1.0 or 1.5% when comparing Ewaise results with Zebda and Alphonse. Moreover, Zebda leaves, in general, had relatively lower phosphorus content as compared with Ewaise and Alphonse leaves.

The effect of the interaction between treatments and cultivars on potassium content in the leaves of the three cultivars of mango was shown in Table 11. The data indicated that the three mango cultivars in the control plants varied in their ability to accumulate potassium where Ewaise and Alphonse had significantly higher potassium content that found in Zebda. However, the application of Ethrel at various used concentrations led to a significant increase in potassium content in the leaves of Zebda. Moreover, increasing the concentration of Ethrel did not make a significant difference in the amount of potassium in Zebda leaves. On the contrary, higher content of potassium was obtained in Ewaise leaves as the concentration of Ethrel reached to 1.5%. In Alphonse, only 1% of Ethrel needed to achieve the highest content of potassium. Thus, Alphonse leaves were more responsive to Ethrel treatment in terms of their ability to accumulate potassium as compared with Ewaise and Zebda. In general, Zebda and Alphonse leaf content of potassium responded in a considerable way to Ethrel treatment and achieved their greatest potential in that aspect at 1% concentration .

The interaction between treatments and cultivars also affected the total carbohydrates in mango leaves. The data in (Table 11) provided evidence that increasing Ethrel concentration to 1% or 1.5% caused a significant increase in total carbohydrates of the leaves in the three used cultivars as compared with the control. Moreover, as the concentration of sprayed Ethrel increased, more carbohydrates accumulated in the leaf tissues in the three used cultivars.

All used concentrations of Ethrel caused a significant increase in total carbohydrates as compared with the control in Zebda leaves. Moreover, Ethrel at 1% on Zebda resulted in a similar percentage of total carbohydrates as compared with that found with in Ewaise or Alphonse leaves at the same concentration. Thus, Ethrel spray at 1% or 1.5% made a significant contribution to increasing total carbohydrates in the young mango trees when compared with the control.

With regard to the percentage of proteins in the leaves as influenced by the interaction between treatment and cultivars (Table 11). It was evident that Ethrel at the three used concentrations did not significantly affect the percentage of proteins as compared with the control in Zebda. However, Ethrel spray at 1% on Alphonse resulted in the highest percentage of proteins in the leaves. Moreover, Ethrel at 1% or 1.5% resulted in significantly higher protein content than that obtained in the controls of the three cultivars. The increase in protein percentage was not in proportion to the increase in Ethrel concentrations in the three cultivars. However, the trend of increasing protein content as the concentration of Ethrel increased was clear in Ewaise.

Table (1): Floral induction and some panicle characteristics as influenced by spraying various Ethrel concentrations on young mango trees during the two seasons 2003 and 2004.

Character / Treatment	Total No. of Panicles		Thickness of Rachis at the Base (cm)		Length of Panicles (cm)	
	2003	2004	2003	2004	2003	2004
Control	0.00^{c*}	0.0c	ND**	ND	ND	ND
Ethrel (0.5%)	1.08^{b}	1.66^{b}	0.56^{b}	0.57^{c}	14.64^{b}	17.5^{c}
Ethrel (1.0%)	2.25^{a}	2.75^{a}	0.58^{b}	0.61^{b}	16.83^{ab}	20.50^{b}
Ethrel (1.5%)	1.58^{b}	2.66^{a}	0.63^{a}	0.66^{a}	19.58^{a}	22.58^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** ND: means no data since there was no floral initiation.

Table (2): Leaf area and some characteristics of the canopy and root system as influenced by spraying various Ethrel concentrations on young mango trees during two seasons 2003 and 2004.

Character / Treatment	Leaf Area (cm^2)		Fresh Weight of Vegetative Growth (gm)	Dry Weight of Vegetative Growth (gm)	Fresh Weight of Root System (gm)	Dry Weight of Root System (gm)
	2003	2004	2004**	2004	2004	2004
Control	102.5^{a*}	94.00^{a}	118.76^{c}	60.47^{c}	160.93^{b}	88.28^{b}
Ethrel (0.5%)	81.23^{a}	82.72^{a}	152.92^{b}	89.41^{b}	211.54^{ab}	119.5^{ab}
Ethrel (1.0%)	92.49^{a}	88.29^{a}	159.29^{b}	95.15^{b}	203.29^{ab}	123.29^{ab}
Ethrel (1.5%)	84.16^{a}	85.78^{a}	194.58^{a}	126.25^{a}	247.67^{a}	150^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data were taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

Table (3): Percentage of some macro nutrients, total carbohydrates, C/N ratio and protein in the leaves of young mango trees as influenced by spraying various Ethrel concentrations during 2004 season.**

Character / Treatment	N (%)	P (%)	K (%)	Total carbohydrates (%)	C / N (Ratio)	Protein (%)
Control	1.60^{b*}	0.37^{b}	0.59^{d}	17.41^{c}	10.78^{a}	1.00^{c}
Ethrel (0.5%)	1.87^{a}	0.41^{a}	0.62^{c}	17.41^{c}	9.48^{a}	1.1655^{b}
Ethrel (1.0%)	1.96^{a}	0.28^{c}	0.65^{b}	17.7^{b}	10.49^{a}	1.381^{a}
Ethrel (1.5%)	1.90^{a}	0.24^{d}	0.67^{a}	18.06^{a}	9.81^{a}	1.329^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data were taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

Table (4): Floral induction and some panicle characteristics as influenced by the variations in cultivars of young mango trees during the two seasons 2003 and 2004.

Character / Cultivar	Total No. of Panicles		Thickness of Rachis at The Base (cm)		Length of Panicles (cm)	
	2003	2004	2003	2004	2003	2004
Ewaise	1.18a*	1.75a	0.70^{a}	0.73^{a}	15.83^{b}	19.5^{b}
Zebda	1.08^{a}	1.69^{a}	0.57^{b}	0.62^{b}	14.55^{b}	18.0^{b}
Alphonse	1.31^{a}	2.18^{a}	0.48^{c}	0.50^{c}	21.18^{a}	23.08^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

Table (5): Leaf area and some characteristics of the canopy and root system as influenced by the variations in cultivars of young mango trees during 2003 and 2004 seasons.

Character / Cultivar	Leaf Area (cm^2)		Fresh Weight of Vegetative Growth (gm)		Dry Weight of Vegetative Growth (gm)	Fresh Weight of Root System (gm)	Dry Weight of Root System (gm)
	2003	2004	2003	2004	2004	2004**	2004
Ewaise	91.62^{a*}	91.7^{a}	–	137.13^{b}	79.28^{a}	194.19^{a}	115.16^{a}
Zebda	95.31^{a}	92.43^{a}	–	165.34^{a}	99.69^{a}	236.16^{a}	137.88^{a}
Alphonse	70.95^{b}	72.66^{b}	–	166.69^{a}	99.49^{a}	187.23^{a}	107.78^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data were taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

Table (6): Percentage of some macro nutrients, total carbohydrates, C/N ratio and protein in the leaves of young mango trees as influenced by the variations in cultivars during 2004 season.**

Character / Cultivar	N (%)	P (%)	K (%)	Total carbohydrates (%)	C / N (Ratio)	Protein (%)
Ewaise	1.58^{c*}	0.335^{b}	0.61^{c}	17.66^{a}	11.52^{a}	1.183^{b}
Zebda	1.80^{b}	0.260^{c}	0.63^{b}	17.62^{a}	9.75^{b}	1.142^{b}
Alphonse	2.10^{a}	0.390^{a}	0.65^{a}	17.68^{a}	9.16^{b}	1.333^{a}

* Values, within a column, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data were taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

Table (7): The interaction between treatments and cultivars in terms of their influence on floral induction and some panicle characteristics during 2003 season.

Cultivar / Treatment	Total No. of Panicles			Panicle Length			Panicle Thickness		
	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse
Control	0.00^{e*}	0.00^{e}	0.00^{e}	ND	ND	ND	ND	ND	ND
Ethrel (0.5%)	1.25^{cd}	1.00^{d}	1.00^{d}	11.25^{bc}	12.00^{b}	21.67^{a}	0.66^{a}	0.52^{b}	0.44^{bc}
Ethrel (1.0%)	1.75^{c}	2.25^{b}	2.75^{a}	17.00^{ab}	13.75^{ab}	19.75^{a}	0.69^{a}	0.56^{ab}	0.48^{bc}
Ethrel (1.5%)	1.75^{c}	1.50^{c}	1.50^{c}	19.25^{a}	14.25^{a}	22.25^{a}	0.75^{a}	0.61^{ab}	0.51^{b}

* Values, within each trait, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** ND: means no data since there was no floral induction in the control trees.

Table (8): The interaction between treatments and cultivars in terms of their influence on floral induction and some panicle characteristics during 2004 season.

Treatment \ Cultivar	Total No. of Panicles			Panicle Length			Panicle Thickness		
	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse
Control	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethrel (0.5%)	1.5^{b*}	1.75^{ab}	1.75^{ab}	16.25^{c}	15.25^{c}	21.00^{ab}	0.68^{ab}	0.55^{bc}	0.48^{c}
Ethrel (1.0%)	2.50^{a}	2.50^{a}	3.25^{a}	20.25^{ab}	17.25^{c}	24.00^{a}	0.72^{a}	0.61^{b}	0.50^{c}
Ethrel (1.5%)	2.50^{a}	2.25^{ab}	3.25^{a}	22.00^{a}	21.50^{a}	24.25^{a}	0.78^{a}	0.67^{ab}	0.53^{c}

* Values, within each trait, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** ND: means no data since there was no floral induction in the control trees.

Table (9): The interaction between the treatments and cultivars in terms of their influence on some characteristics of the canopy and root system during 2004 season.**

Treatment \ Cultivar	Fresh Weight of Vegetative Growth (gm)			Fresh Weight of Root System (gm)			Dry Weight of Vegetative Growth (gm)			Dry Weight of Root System (gm)		
	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse	Ewaise	Zebda	Alphonse
Control	94.78^{bc*}	148.50^{ab}	113.00^{ab}	142.5^{e}	219.00^{b}	121.30^{e}	40.58^{bc}	75.25^{ab}	65.58^{ab}	83.25^{cd}	117.75^{b}	63.85^{c}
Ethrel (0.5%)	121.75^{ab}	153.50^{a}	183.50^{a}	177.50^{d}	243.13^{ab}	214.00^{bc}	66.23^{ab}	98.00^{a}	104.00^{a}	101.25^{bc}	134.25^{ab}	123.00^{b}
Ethrel (1.0%)	141.00^{ab}	162.13^{a}	174.75^{a}	185.00^{d}	253.25^{a}	171.63^{d}	81.83^{ab}	94.25^{ab}	109.38^{a}	118.00^{b}	154.75^{a}	97.125^{c}
Ethrel (1.5%)	191.00^{a}	197.25^{a}	195.5^{a}	271.75^{a}	229.25^{ab}	242.00^{ab}	128.50^{a}	131.25^{a}	119.00^{a}	158.13^{a}	144.75^{a}	147.125^{a}

* Values, within each trait, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data was taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

Table (10): The interaction between the treatments and cultivars in terms of their influence on leaf area during 2003 and 2004 seasons.

Cultivar / Treatment	Leaf area (cm²)					
	Ewaise		Zebda		Alphonse	
	2003	2004	2003	2004	2003	2004
Control	86.00^{a*}	87.20^{a}	84.20^{a}	80.01^{a}	62.10^{ab}	64.30^{ab}
Ethrel (0.5%)	92.9^{a}	92.50^{a}	88.83^{a}	83.74^{a}	61.96^{ab}	71.93^{ab}
Ethrel (1.0%)	94.50^{a}	94.83^{a}	99.67^{a}	96.28^{a}	83.31^{a}	73.76^{ab}
Ethrel (1.5%)	87.48^{a}	87.78^{a}	97.43^{a}	97.28^{a}	67.58^{ab}	72.30^{ab}

* Values, within each season, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

Table (11): The interaction between treatments and cultivars in terms of their influence on some macro nutrients, total carbohydrates, C/N ratio and protein during 2004 season.**

Cultivar / Treatment	N (%)			P (%)			K (%)			Total Carbohydrates (%)			C / N (Ratio)			Protein (%)		
	Ewnise	Zebda	Alphonse	Ewnise	Zebda	Alphonse	Ewnise	Zebda	Alphonse	Ewnise	Zebda	Alphonse	Ewnise	Zebda	Alphonse	Ewnise	Zebda	Alphonse
Control	1.42^{dc*}	1.74^{c}	1.63^{dc}	0.40^{b}	0.25^{de}	0.47^{a}	0.60^{de}	0.58^{f}	0.61^{d}	17.42^{d}	17.43^{d}	17.37^{d}	12.27^{a}	10.02^{b}	10.05^{b}	0.89^{d}	1.09^{c}	1.020^{cd}
Ethrel (0.5%)	1.89^{c}	1.85^{c}	1.89^{c}	0.48^{a}	0.30^{d}	0.46^{a}	$0.60d^{e}$	0.64^{bc}	0.62^{d}	$17.51d$	17.27^{de}	17.43^{d}	9.29^{b}	9.36^{b}	9.79^{b}	1.165^{c}	1.155^{c}	1.176^{bc}
Ethrel (1.0%)	1.37^{cd}	1.81^{c}	2.70^{a}	0.25^{de}	0.27^{d}	0.35^{c}	0.61^{d}	0.65^{b}	0.68^{a}	17.72^{bc}	17.8^{b}	17.72^{bc}	13.54^{a}	10.10^{b}	7.85^{bc}	1.325^{b}	1.131^{c}	1.69^{a}
Ethrel (1.5%)	1.65^{dc}	1.91^{c}	2.17^{b}	0.22^{e}	0.24^{de}	0.27^{d}	0.64^{bc}	0.66^{b}	0.69^{a}	18.00^{a}	17.98^{ab}	18.18^{a}	10.97^{ab}	9.53^{b}	8.94^{bc}	1.35^{b}	1.194^{bc}	1.444^{b}

* Values, within each trait, of similar letters are not significantly different according to using the least significant difference at 0.05 level to compare the means.

** Data were taken for the second season only since the whole vegetative growth and root system were used for the assay in that season.

REFERENCES

A. O. A. C. (1983): Association of Official Agriculture Chemistry: Official Methods of Analysis. 12th Ed. pp. 83 & 121. Washington, D.C.

Ahmed, F.F. and Morsy, M.H. (1999). A new method for measuring leaf area in different fruit species. Minia Journal of Agriculture, Res. 8. Vol. 1 : 97-104.

Ahmed, Y.M. (2000). Morphological and biochemical studies on some mango cultivars grown in Asswan governorate. Doctor of Philosophy thesis in Horticulture (Pomology). Minia University, Faculty of Agriculture. PP. 182.

Avilan, R. L. (1971). Variations in mango leaf contents of N, P, K and Ca during a productive cycle. *Agron. Trop. Maracay, 21: 3-10.*

Barbra, R. C. (1974): Induction of flowering of the mango by chemical spray. Proceeding of the Crop Science Society of the Philippines. 5, 154-160.

Bondad, N. D. (1972): Effect of 2-Chloroethane-phosphonic acid on some Philippine horticultural crops. Philippine Journal of Geography 16, 31-35.

Bondad, N. D. (1976): Response of some tropical and subtropical fruits to pre- and post-harvest applications of ethephon. Economic Botany 30. 67-80.

Chacko, E. K. (1991): Mango flowering-still an enigma. Acta Horticulturae 291: 12-21.

Chacko, E. K.; Kohli, R. R. and Randhawa, G. S. (1972a): Flower induction in mango by chloroethyl phosphonic acid and its possible use in control of biennial bearing. *Current Science 41, 500-501.*

Chacko, E. K.; Kohli, R. R. and Randhawa, G. S. (1972b): Studies on the effect of 2-chloroethyl phosphonic acid (Ethrel) on mango. I. Flower induction in an 'off' year in Langra trees. *Indian Journal of Horticulture 29, 1-4.*

Chadha, K. L. and Pal, R. N. (1986): *Mangifera indica*. In: Halevy, A. C. (ed) C. R. C. Hand book of Flowering, vol. 5. CRC press. Baco Raton, Florida, pp. 211-230.

Chen, W. S. (1985): Flower induction in mango *(Mangifera indica* L.) with plant growth substances. Proceedings National Science Council Part B, Life Sciences Taipei, Republic of China 9, 9-12.

Cull, B. W. (1991): Mango crop management. Acta Horticulture 291.154-173.

Das G. C.; Sahoo S. C. and Ray D. P. (1988): Studies on effect of gibberellic acid,urea, ethrel alone or in combination on the growth and flowering behavior of some "On" and "Oft" year shoots in Langra mango. Department of Horticulture – Orissa Univ. of Agriculture and Technology, Bhubanewar, India – Acts Horticulturea 231 mango.

Das, G. C.; Sahoo. S. C. and Ray. D. P. (1989): Studies on effect of gibberellic acid and urea either alone or in combination on the growth and flowering behavior of some 'on' and 'off' year shoots in Langra mango. Acta Horticulturae 231: 495-499.

Davenport, T. L. (1993): Floral manipulation in mangos. Chia, L. E. and Evans, D. O. (eds.) Proceedings of the Conference on Mango in Hawaii. Cooperative Extension Service, University of Hawaii, Honolulu, pp. 54-60.

Davenport, T. L. and Núñez-Elisea, R. (1990): Ethylene and other endogenous factors possibly involved in mango flowering. Acta Horticulturae 275, 441-448.

Davenport, T. L. and Núñez-Elisea, R. (1990): The role of Ethylene in mango floral induction. Tropical Research and Education Center, IFAS, University of Florida, Homestead, FL 33031, USA. Proceedings of the plant Growth Regulator Society of America. 17th Annual Meeting, St. Paul, Minnesota, USA., 5-9 August 1990, 11 ref : 22-24.

Davenport, T. L. and Núñez-Elisea, R. (1991): Is endogenous ethylene involved in flowering of mango. Acta Horticulturae 291. 85-94.

Ebeed, S. S. (1989): Physiological studies on the growth, flowering and yield in mango trees. *M. Sc. Thesis, Fac. Agric., Ain Shams Univ. Cairo, Egypt. P. 99.*

El-Beltagy, M. S.; El-Ghandour M. A., and Hennawi H. S., (1979): Effect of Bayfolan and some growth regulators on modifying flowering and the incidence of flower malformation of mango (Mangifera indica L.). Egypt J. Hort., 6: 125-133.

FAO. (2005). Food and Agricultre Organization of the United Nations Internet site. Agricultural statistics. www.fao.org. Oct.2006.

Galila, S. A. and H. M. El-Masry, (1991): Effect of Ethrel and (A new plant growth retardant) on flowering, malformation, fruit set and yield of Ewais mango cultivar. Annals Agric. Sci. Ain Shams Univ. Cairo, 36(2): 645-650.

Gonzales, L. G. (1923): The smudging of mango trees and it's effects. Philippine Agriculturist 12, 15-27.

Kulkarni, V. J. (1991): Physiology of flowering in mango studied by grafting. Acta Horticulturae.291, 95-104.

Maiti, S. C. and P. K. Sen (1989): Effect of growth retardants on flowering and fruiting of Langra mango. *Curr. Sci., 7: 565-567.*

Maiti, S. C.; Mukhopadhyaya, A. K. and Sen, P. K. (1971): Effect of growth retardants on flowering and apical dominance of mango. *Current Science* 40, 388.

Mukhopadhaya, A. K. (1976): A note on the effect of growth regulators and 1-methionone on flowering of mango. *Haryana J. Hort. Sci., 5(3/4):169-171.*

Núñez-Elisea, R.; Becerril-Roman, A. E. and Diaz-Montenegro, D. (1979): Efectos del rthrel sobre la floracion en mango cv. Haden. Proceedings of the Tropical Region of the American Society for Horticultural Science 23, 138-140.

Pandey, R. M.; Singh, R. N. and Sinha, G. C. (1973): Usefulness of Ethrel in regulating flower bearing in mango. Science and culture 39-148-150.

Pantastico, E. B. and Manuel, F. C. (1978): The Philippines Recommends for Mango 1979. Report for Philippines Council for Agriculture. PCARR, 43 pp.

Rabelo, J. D. S.; F. A. Couto; D. L.; Siqueira and G. C. L. Neves (1999): Flowering and fruit set in Haden mango trees in response to ringing and ethephon and potassium nitrate sprays. Rivista Brasileria de Fruticultura 21(2): 135-139.

Rath, S. and Das, G. C. (1979): Effect of ringing and growth retardants on growth and flowering of mango. Scientia Horticulturae 10. 101-104.

Saidha, T.; Rao, V. N. M. and Santhanakrishnan, P. (1983): Internal leaf ethylene levels in relation to flowering in mango (Mangifera indica L.) Indian Journal of Horticulture 40: 139-145.

Sanyal, D. and S.K. Mitra (1999): Studies on irregular bearing of mango (Mangifera indica L.) II. Changes in mineral composition of leaf and shoot in relation to fruit bud differentiation. Advances in Horticulture and Forestry 6:1-7.

Sen, P. K.; Bando Padhyay, M.; Roy, S. S. and Basu, R. N. (1973): Use of Ethrel in controlling non-uniform bearing of mango (*Mangirina indica* L.). Indian Agriculture 17: 285-288.

Shaban, A. E. A. (2004): Effect of Ethrel Spraying on Inducing Flowering in the "off" year of mango trees. Annals Agric. Sci., Ain Shams University., Cairo, 49(2): 687-698.

Sharma. J.N.; Jason, J.S.; Thind, S.K. and Arora, P.K. (1999). Evaluation of mango cultivars for arid regions. Journal of Applied Hort. Lucknow. 1: 103-104.

Suryanarayana, V. (1980a): Seasonal changes in sugars, starch, nitrogen and Carbon - nitrogen ratio in relation to flowering in mango. Plant Biochemistry Journal 5: 108-117.

Suryanarayana, V. (1980b): Amino acid changes in mango shoots in relation to flowering. Plant Biochemistry Journal 5: 50-57.

Wester, P. J. (1920): The Mango. Philippine Bureau of Agriculture Bulletin 18, 3-70.

Whiley, A. W.; Rasmussen, T. S.; Wolstenholme, B. N.; Saranah, J. B. and Cull, B. W. (1991): Interpretation of growth responses of some mango cultivars grown under controlled temperatures. Acta Horticulturae 291: 22-31.

Winston, E. C. and Wright, R. M. (1986): Mango flower induction - ethephon, potassium nitrate and cincturing. Proceedings of the 1st Australian Mango Research Workshop. CIRO, Melbourne, pp. 202-210.

Zidan, Z.; Shawky, I. and Dahshan, D. (1975): Flower bud induction in mango trees. Annals Agric. Sci. Ain Shams University, Cairo, 20, 151-158.

الملخص العربى

تاثير الايثريل على حدوث التكشف الزهرى فى ثلاث اصناف تجارية من اشجار المانجو صغيرة السن

كريم محمد فرج1، أيمان محمد شكرى2، ، أحمد سعيد الصباغ1

1 قسم البساتين (فاكهة)، كلية الزراعة بدمنهور، جامعة الاسكندرية ص ب 22516 ، دمنهور.

2 مديرية التموين ، وزارة التضامن الاجتماعى ، دمنهور.

اجريت هذة الدراسة خلال عامى 2003 ، 2004 باستخدام اشجار مانجو صغيرة السن لثلاث اصناف تجارية و هى زبدة و الفونس و عويس ، و النامية فى اصص كبيرة تحت ظروف الحقل المفتوح، و تلخصت اهداف البحث فى دراسة تاثير الايثريل (الاثيفون) على التكشف الزهرى فى تلك الاشجار ، و كذلك دراسة العلاقة بين انتاج الايثيلين و العوامل الغذائية من ناحية تاثيرها على التكشف الزهرى بالاضافة لتوفير طريقة امنة للمزراعين للتحكم فى ازهار تلك الاشجار صغيرة السن، و قد اشتملت المعاملات على استحدام ثلاثة تركيزات من مركب الايثريل (تركيزة الاصلى 48% حجم / حجم) هى 0.5 ، 1 ، 1.5% بالاضافة للكنترول و تم رش الاشجار مرتين فى الفترة السابقة لحدوث التميز الزهرى (فى الاسبوع الاخير من نوفمبر و الرشة الثانية فى منتصف ديسمبر فى كل موسم) ، و قد كانت كل تركيزات الاثيريل المستخدمة فعالة فى احداث التكشف الزهرى فى تلك الاشجار، بينما لم يكن هناك اى تكشف فى اشجار الكنترول للاصناف الثلاثة المستخدمة، و قد نتج عن استخدام الاثيريل بتركيز 1% عدد أكبر من العناقيد الزهرية بالمقارنة بتركيزى 0.5 ، 1.5% من نفس المركب ، و كانت

هناك زيادة فى سمك الحامل الزهرى كلما زاد تركيز الاثيريل ، كما زاد طول العنقود الزهرى بزيادة التركيز المستخدم من الايثريل لكنة لم يؤثر معنويا على مساحة الورقة فى كلا الموسمين، و قد نتج عن رش الاثيريل بتركيزى 0.5 او 1% زيادة معنوية فى الوزن الطازج للمجموع الخضرى للنبات بالمقارنة بالكنترول، اما الايثريل بتركيز 1.5% فكان تاثيرة معنويا على الوزن الطازج للمجموع الخضرى بالمقارنة بالكنترول و كذلك باى من تركيزى الايثريل 0.5 ، 1% ، كما كان اتجاة النتائج فى حالة الوزن الجاف للمجموع الخضرى للاشجار مشابها لما تم التحصل عليه من نتائج الوزن الطازج لها، كما ادى الايثريل بتركيز 1.5% الى حدوث زيادة معنوية فى الوزن الطازج و الجاف للمجموع الجذرى للاصناف الثلاثة و بالمقارنة بالكنترول و بتركيزى 0.5 ، 1%.

كما ادى رش الايثريل بتركيزاته المختلفة الى حدوث زيادة معنوية فى تركيز النيتروجين فى الاوراق بالمقارنة بالكنترول ، بينما لم يكن هناك فرق معنوى بين هذة التركيزات من ناحية تاثيرها على محتوى النيتروجين، بينما كانت العلاقة عكسية بين تركيز الايثريل و محتوى الفوسفور فى الاوراق ، اما بالنسبة لعنصر البوتاسيوم فلقد زادت نسبته مع زيادة تركيز الايثريل و بالتالى فقد ادت المعامله بالايثريل الى زيادة قدرة اوراق المانجو على تراكم عنصر البوتاسيوم و ذلك بالمقارنة بالكنترول، كما زادت كمية الكربوهيدرات فى الاوراق فى الاصناف الثلاثة بزيادة تركيز الاثيريل ، كما اتضح انه لم تكن هناك علاقة بين قدرة الايثريل على احداث التكشف الزهرى فى تلك الاشجار

وبين نسبة الكربوهيدرات الى النتروجين ، و بالنسبة لتاثير الصنف فلم تختلف الاصناف الثلاثة معنويا فى عدد العناقيد الزهرية لكل نبات خلال موسمى الدراسة، و كان سمك الحامل الزهرى فى الصنف عويس اكبر من ذلك الخاص بالصنف زبدة، و الذى بدوره كان اكبر من سمك الحامل الزهرى عند القاعدة فى الصنف الفونس، اما اطول عنقود زهرى فكان للصنف الفونس بالمقارنة بكل من عويس و زبدة، بينما اوضحت الدراسة ان المساحة الورقية لكل من الصنفين عويس و زبدة كانت اكبر معنويا بالمقارنة بالصنف الفونس فى كلا الموسمين وبناءا على التفاعل بين تاثير المعاملات و الصنف ، فانه يمكن التوصية باستخدام الإيثريل رشا على اشجار المانجو الصغيرة السن بتركيز 0.5% للصنف عويس، او بتركيز 1% على اشجار الصنفين زبدة و الفونس لاحداث التكشف الزهرى.