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PANICLES CHARACTERISTICS OF MATURE ALPHONSE MANGO TREES AS INFLUENCED BY SOME AUTUMN - WINTER FOLIAR SPRAYS WITH UREA, GA_3 AND PBZ

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ABSTRACT

In 2001/ 2002 and 2002/2003 seasons, mature Alphonse mango tree received 4 foliar sprays at monthly intervals from mid Oct. to mid Jan. The tested treatments were : Cont. (water), GA_3 (alone) at 10 ppm, GA_3 (alone) at 20 ppm , Paclobutrazol (PBZ) (alone) at 500 ppm , PBZ (alone) at 1000 ppm, urea (alone) at 1%, GA_3 10 ppm + urea 1% , GA_3 20 ppm + urea 1% , PBZ 500 ppm + urea 1% and PBZ 1000 ppm + urea 1 %.

GA_3 at both tested concentrations, with / or without urea , tended to delay panicle emergence , flowering and fruit set, increased number of perfect flowers/ panicle and panicle length. Worthwhile, the same treatments tended to increase the number of healthy panicles and total number of panicles / tree, while obviously depressed number of malformed panicles / tree and malformation percentage.

On the other hand, treatments implying PBZ at both tested concentrations, (500 & 1000 ppm) , with / or without urea , tended to advance panicle emergence , flowering and fruit-set. The same treatments increased number of panicles / tree but also increased number of malformed panicles/ tree and malformation %. Also, treatments implying PBZ , particularly at the higher concentration (1000 ppm) greatly increased number of male flowers and total number of flowers/ panicle and promoted the sex ratio (male : perfect flowers).

The malformed panicles revealed higher contents of total phenols and total free amino acids as well as endogenous IAA and ABA as compared with healthy ones. On the other hand, the malformed panicles exhibited lower total indoles and endogenous GA as compared with healthy ones.

INTRODUCTION

Mango (*Mangifera indica* L.) has a great importance in the Egyptian fruit production. Egypt ranks 10th among mango producing countries with total production of 232.000 m. ton (FAO, 2000). Unfortunately, mango trees suffer from colossal losses due to malformation (Singh, 2000). Kumar and Chakrabarti (1997) determined yield losses for Neelam, Langra, Himsagar and Gilas mango cvs. to be : 36.2, 2.3, 15.7 and 41.5% respectively. The yield declined by 0.2, 0.6, 0.89 and 0.96% for every 1% increase in the number of malformed panicles in Langra, Himsagar , Gials and Neelam, respectively.

The factors causing malformation have been of great concern since first discovered (Ram, 1991). However, many factors were reported as causes of mango malformation; among them: environmental factors, infection by fungi , mites and viruses. In addition, the malformation

phenomenon was interpreted to changes in endogenous carbohydrates, nucleic acids, amino acids, proteins, phenolic compounds, enzymatic activity, phytohormones and occurrence of malformin - like substances.

Different attempts have been made to control malformation by application of growth regulators, nutrients, pesticides, phenolic compounds, anti-malformins and deblossoming as well as different combinations between them. Therefore, the present study aimed mainly to investigate the effect of foliar spraying a growth promoter (GA_3) and a growth inhibitor (Paclobutrazol, i.e. PBZ) as well as a nitrogen source (urea) on the incidence of floral malformation in the mango cultivar Alphonse. The treatments were applied once monthly from Oct. 15th to Jan. 15th in both the study seasons (2001/2002 and 2002/2003) . The effects of tested treatments on panicle characteristics particularly malformation, as well as flowering, fruiting and vegetative growth were assessed. The present paper is specified for the effect of tested treatments on panicles characteristics.

MATERIALS AND METHODS

The present investigation was carried out during the two consecutive seasons of 2001 /2002 and 2002/2003 on mature Alphonse mango trees (*Mangifera indica* L.) grown in the experimental orchard of El-Kassasin Horticultural Research Station, Ismailia Governorate. The soil under tree was sandy and the trees were under drip irrigation system using a moderately saline irrigation water (890 ppm).

Before the beginning of each experimental season (i.e. in late summer of the previous season) 90 mature Alphonse mango trees were selected for nearly similar size and being in their off - bearing year. Experimental trees of the second season were other than those used in the first season. The trees received a uniform orchard management practices concerning irrigation, soil fertilization, pruning , pests and weeds control following the usual management programme applied in the region. Meanwhile, the experimental trees received different monthly foliar spray treatments from mid - Oct. to mid - Jan. The tested ten foliar spray treatments were: 1- Control (water); 2- Gibberellic acid (GA_3) at 10 ppm; 3-GA_3 at 20 ppm; 4- Paclobutrazol (PBZ) at 500 ppm; 5-PBZ at 1000 ppm; 6-Urea at 1% ; 7-GA_3 10 ppm + urea 1% ; 8-GA_3 20 ppm + urea 1% ; 9-PBZ 500 ppm + urea 1% and 10 -PBZ 1000ppm +urea 1%. Each treatment comprised nine trees, chared between three replicates.

The following parameters were considered to evaluate the effect of tested treatments dates of beginning and end of panicle emergence; date of beginning flower opening ; date of first fruit-set, i.e. when fruitlets reached the pin-head stage; numbers of healthy and malformed panicles and total number of panicles per tree as well as malformation%.

$$\text{Malformation \%} = \frac{\text{No of malformed panicles / tree}}{\text{Total no of panicles / tree}} \times 100$$

Length and diameter of panicles (cm) were measured at time of anthesis, using 24 detached panicles per tree (at random). The measurements were carried out for healthy and malformed panicles.
Sex expression: the same detached panicles were used to count total number of flowers, numbers of male and perfect flowers for each panicle. The sex ratio was then calculated = $\frac{\text{No of male flowers/ panicle}}{\text{No of perfect flowers/ panicle}}$

Some chemical constituents of healthy and malformed panicles

Samples of healthy and malformed panicles were randomly taken from control trees at full bloom. The samples (36 panicles each) were cut into small pieces, then weighed, crushed with 80% methyl alchohol at 0°C in a porcelain mortar and extracted for 72 hours as described by Daniel and George, (1972). The methanolic extraction was transferred into aqueous phase by evaporating methyl alcohol at 30 ± 2°C under vacuum . Afterthat, it was filtered using Whatman filter paper no. 1 and activated charcoal to get rid of pigments. The residue was dried in an oven at 80°C for 72 hours to determine dry weight .The aqueous phase was used for determination of: total amino acids, indoles, phenols and hormones - like substances i.e. IAA, GA_3 and ABA.

Total amino acid: The ninhydrin colourimetric method according to Rosein , (1957) and modified by Selim *et al.,* (1978) was used for determining total amino acids colourimetrically at 570 nm wave length . The concentration was calculated from the standard curve of alanine as mg/g dry weight.

Total indoles: The P-dimethyl amino benzaldehyde test (Ehrlich reagent , Larsen *et al.* 1962) , modified by Selim *et al.* (1978) to obtain a stable pink colour was used . Total indoles were estimated colourimetrically at 530 nm wave length, the concentration was calculated as mg IAA/g dry weight.

Total phenols: was determined by the Folin - Dennis colourimetric method (A.O.A.C. 1975) at 730 nm wave length. The concentration was calculated from a standard curve of pyrogallol as mg/ g dry weight.

Determination of hormone- like substances : The aqueous phase of the previous extracts were purified as described by Shindy and Smith , (1975) and Ren *et al.* (1997) . A (HPLC) Hewlett Packard series 1050 equipped with a low variable U.V. visible spectrophotometric detector was used for separation and determination of IAA, GA_3 and ABA as described by Ren *et al.* (1997).

Experimental design and statistical analysis

The complete randomized block design with three replicates was followed throughout the whole work. Each replicate was represented by three trees; as such the total number of experimental trees was 90 (10 treatments x 3 replicates x 3 trees/ replicate) . The obtained data were subjected to analysis of variance and the LSD method was used for comparison between means (Snedecor and Cochran , 1980).

RESULTS AND DISCUSSION

1.Dates of panicle emergence , flower opening & fruit-set

Data in Table (1) indicate that GA_3 (alone) and urea (alone) delayed panicle emergence, flowering and fruit-set in comparison with the control . The higher tested GA_3 concentration (20 ppm) was more effective than the lower concentration (10 ppm). However, the most prominent delays were induced by the combined treatment: (GA_3 20 ppm + urea), which delayed first panicle emergence by (6 & 11 days), end of panicle emergence by (5 & 4 days), first flowering by (9& 15 days) and first fruit-set by (10 & 14 days) in the first & second seasons, respectively as compared with the control.

Table (1) **Effect of some GA_3, PBZ and urea foliar spray treatments on dates of: first panicle emergence, end of panicles emergence, first flower opening and first fruit set in Alphonse mango trees (2001/2002 and 2002/2003 seasons).**

Foliar spray treatments	Date of : First panicle emergence		End of panicle emergence		First flower opening		First fruit set	
	2001/ 2002	2002/ 2003	2001/ 2002	2002/ 2003	2001/ 2002	2002/ 2003	2001/ 2002	2002/ 2003
Cont (water)	27/2	25/2	13/3	11/3	22/3	20/3	31/3	29/3
GA_3 10 ppm	1/3	2/3	13/3	16/3	25/3	26/3	5/4	¾
GA_3 20 ppm	2/3	5/3	16/3	19/3	27/3	29/3	7/4	11/4
PBZ 500ppm	26/2	21/2	11/3	7/3	18/3	14/3	27/3	23/3
PBZ 1000ppm	24/2	16/2	8/3	2/3	16/3	8/3	26/3	19/3
Urea 1%	1/3	5/3	14/3	19/3	24/3	28/3	¾	7/4
GA_3 10 ppm + urea1%	3/3	6/3	17/3	18/3	28/3	28/3	8/4	8/4
GA_3 20 ppm + urea1%	5/3	8/3	18/3	25/3	31/3	4/4	10/4	12/4
PBZ 500 ppm + urea 1%	28/2	24/2	12/3	9/3	22/3	21/3	30/3	31/4
PBZ 1000 ppm+urea 1%	26/2	21/2	10/3	8/3	19/3	13/3	29/3	26/3

On the contrary PBZ (alone) induced earlier occurrence of all considered panicle activities. The higher tested concentration (1000 ppm) was more effective and advanced first panicle emergence by (3 & 9 days) end of panicle emergence by (5 & 9 days) , first flowering by (6 & 12 days) and first fruit-set by (6 & 10 days) in the first & second seasons, resoectivelv

to the more cool and humid weather. Moreover, pollination and fruit set are usually inferior under such cool and humid weather conditions.

The delay in panicles emergence by GA_3 was in agreement with those of Haggag (1986), Nunez - Elisea and Davenport (1993), Oosthysea, (1995) and Davenport & Smith (1997) , while the delay in anthesis by GA_3 was in line with Turnbull *et al.*, (1996). On the other hand, the advanced panicle emergence by PBZ was reported by Kurian and Lyer, (1993) , Burondkar *et al.* (1997), Salazar and Vazquez (1997), Jose and Reboucas, (2000) and Burondkar *et al.* (2000). The earlier anthesis by PBZ supported the report of Perez *et al.* (2000) , while the advance in fruit set by PBZ confirmed the results of Jose and Reboucas, (2000). In this respect, Turnbull *et al.* (1996) stated that late flowering panicles retained 3- time more fruits than those flowered early , which was possibly related to differences in temperature before or at anthesis (i.e. being higher with late flowering).

2.Number of healthy & malformed panicles and malformation %

As shown in Table (2) , the use of GA_3 (alone) increased total number of panicles/ tree and number of healthy panicles / tree, while depressed number of malformed panicles and percentage of malformation. This was clear in both experimental seasons and was more obvious with the higher GA_3 concentration (20 ppm), which increased total number of panicles/ tree by 11.9 & 13.4% and number of healthy panicles by 22.7% in both seasons, while decreased number of malformed panicles by 28.4 & 25% and decreased malformation incidence by 35.1 & 35.7% in the first and second seasons, respectively in comparison with the control. The use of urea (alone) was effective in depressing number of malformed panicles by 34.6 % 31.3% and malformation incidence by 62.2 & 29.1% in comparison with the control in the 1^{st} & 2^{nd} seasons, respectively. The combined treatment (GA_3 20 ppm + urea) induced the highest increments in total number of panicles / tree (12.5 & 14.5% over the control in the two seasons) and in number of healthy panicles/ tree (29.2 & 27.6% over the control, in the two seasons). The same treatment obviously depressed number of malformed panicles / tree (48.9 & 39.2% less than the control in the two seasons) and the malformation percentage (54.7 & 47% less than the control in the two seasons).

Pacloputrazol application (alone at 500 or 1000 ppm), or in combination with urea clearly increased total number of panicles per tree by about one fifth the number of panicles on control trees. Such increments were mostly due to parallel increments in number of malformed panicles, which were increased by 69.5 & 85.5% by PBZ 500 ppm (alone) , 82.5 & 106% by PBZ 1000 ppm (alone), 54.1 & 73.6% by PBZ 500 ppm + urea and 78.9 & 95.6% by PBZ 1000 ppm + urea in comparison with the control in the first & second seasons, respectively .

The related reports included contradicting response of different mango cvs. to GA_3 treatments concerning floral malformation. Thus, Ibrahim, (1977) found that GA_3 application (100 ppm) at flower - bud - differentiation increased panicle malformation % in Mabrouka cv., while decreased it in Taymour cv. In this respect, Azzouz *et al.* (1980) revealed that GA_3 sprays

depressed floral malformation %, as such spraying GA_3 at 10, 50 & 100 ppm resulted in malformation percentages of 23, 26 & 13% respectively, against 40% for untreated control. Also, Azzouz *et al.*, (1984) reported that GA_3 spray at 100 ppm on Taymour and Pairi mango trees resulted in malformation % of 21.5 & 20.5 % , for the two cvs., respectively , against 68 & 50% respectively, for the untreated controls. Analogical results were reported by Haggag (1986) on Taymour mango trees, Ebeed, (1989) on Pairi and Ewais mango cvs. and Kasem, (2001) on Taimour mango trees. Moreover, Das *et al.* (1989) found that application of GA_3 at 50 ppm to mango shoots in Oct.-Nov. halved malformation incidence in the mango clone Chiratpudi.

However, the present investigation cleared that GA_3 at 20 ppm increased total number of panicles/ tree; this contradicts the results of Nunez-Elisea and Davenport , (1993), Turnbull *et al.* (1996) and Davenport and Smith , (1997) who found that GA_3 treatments depressed number of panicles per tree. Also, Yamdagni and Khazia, (1989) reported that GA_3 at 50 - 1000 ppm depressed the numbers of both healthy and malformed mango panicles. Such contradiction might have relation with the method of application since treatments of the present investigation were applied at 4 monthly doses in the autumn- winter months which was not adopted in previous available reports.

Regarding PBZ effects, many previous reports revealed increments in number of panicles/ tree; this came true with both soil drench treatment (Kurian and Lyar , 1993 ; Burondkar *et al.* 1997 ; Shinde *et al.* 2000; Zora *et al.*, 2000 and Murtie *et al.* 2001) and foliar sprays (Nunez - Elisea *et al.*, 1993 ; Hoda *et al.* 2001 and Mendonka *et al.* 2001). The increase in number and percentage of malformed panicles with PBZ in the present work was not noticed in the previous available reports. This might be due to the multi foliar spray application (4 sprays at monthly intervals in the autumn - winter months) adopted in the present investigation.

In this respect, Singh and Dhillon, (1990) cleared that malformed panicles of the cv. Dusehri maintained lower endogenous GA_3 levels than healthy ones at the stage of fully swollen buds, while the converse was true with the following stages (i..e. bud inception, fully grown panicles and fully blooming panicles). Similar conclusion was suggested by Raafat *et al.* (1995). As such , the four PBZ sprays in the autumn winter months applied in the present work might have depressed the endogenous GA_3 content of apical buds at the early stages of development due to the antigibberellic effect of PBZ . On the other hand, Kasem (2001) found that PBZ spray at 500, 1000 or 2000 ppm decreased malfor-mation % in Taymour cv.

The depressing effect of urea (alone) on number and percentage of malformed panicles confirmed the previous reports by Prasad *et al.* (1965). Shawky *et al.* (1982) , Banik *et al.* (1997) and Thakur *et al.* (2000).

Table (2): Effect of some GA_3 , PBZ and urea foliar spray treatments on total number of panicles, number of healthy panicles, number of malformed panicles and percentage of malformation in Alphonse mango trees (2001/ 2002 and 2002/ 2003 seasons).

Foliar spray treatments	Total number of panicles / tree				Number of healthy panicles / tree				Number of malformed panicles / tree				Percentage of malformation			
	2001/ 2002	*+/-%	2002/ 2003	*+/-%	2001/ 2002	*+/-%	2002/ 2003	*+/-%	2001/ 2002	*+/-%	2002/ 2003	*+/-%	2001/ 2002	*+/-%	2002/ 2003	*+/-%
Cont (water)	465.0	-	472.0	-	365.3	-	379.3	-	99.7	-	92.7	-	21.4	-	19.6	-
GA_3 10 ppm	480.7	+3.3	503.7	+6 7	413.0	+13 0	429.3	+13.1	67.7	-33.1	74.4	-19.8	14.1	-34.2	14.8	-24
GA_3 20 ppm	520.7	+11.9	535.3	+13.4	448.3	+22 7	465.7	+22.7	72.4	-28.4	69.6	-25.0	13.9	-35.1	13.0	-3
PBZ 500ppm	556.3	+19.6	574 3	+21.6	387.3	+6.0	402.3	+6.0	169.0	+69.5	172.0	+85.5	30.4	+42.0	29.9	+5
PBZ 1000ppm	562.7	+21.0	584.3	+23.2	380.7	+4.2	393.3	+3.6	182.0	+82.5	191 0	+106.0	32.3	+50.9	32.7	+6
Urea 1%	434.3	-6.7	457 7	-3.1	399.0	+9.2	394.0	+3.8	35.3	-34.6	63.7	-31.3	8.1	-62.2	13.9	-29
GA_3 10 ppm + urea1%	503.0	+8.1	519.7	+10 1	445 3	+21.9	454.0	+19.6	57 7	-42.2	65.7	-29.2	11.5	-46.3	12.6	-35
GA_3 20 ppm + urea1%	523.3	+12.5	540 7	+14.5	472.3	+29.2	484.3	+27.6	51.0	-48.9	56.4	-39.2	9.7	-54.7	10.4	-47
PBZ 500 ppm + urea 1%	552.7	+18.8	572.3	+21.2	399 0	+9.2	411.3	+8.4	153.7	+54.1	161.0	+73.6	27.8	+29.9	28.1	+43
PBZ 1000 ppm + urea 1%	559.7	+20 3	574.7	+21.7	381.3	+4 2	393.3	+3.6	178.4	+78.9	181.4	+95.6	31.9	+49.0	31.6	+61
L.S.D. 0.05	44.6	-	48.5	-	320	-	35.5	-	16.4	-	13.2	-	4.5	-	5.2	-

Table (3) Effect of some GA_3 , PBZ and urea foliar spray treatments number of male & perfect flowers, total number of flowers and sex ratio on healthy and malformed Alphonse mango panicles (first seasons , 2001/2002

Foliar spray treatments	Male flowers				Perfect flowers				Total				Sex ratio (male / perfect)			
	Healthy		Malformed		Healthy		Malformed		Healthy		Malformed		Healthy		Malformed	
	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%
Cont (water)	842.4	-	2486.0	-	140.7	-	73.8	-	983.1	-	2559.8	-	6.0	-	33.7	-
GA_3 10 ppm	858.4	+1.8	2815.6	+13.2	197.4	+40.2	83.3	+12.8	1055.8	+7.3	2898.9	+13.2	4.3	-28.4	33.8	+0.2
GA_3 20 ppm	796.5	-5.5	2756.0	+10.8	204.7	+45.4	107 3	+45.3	1001.2	+1.8	2863.3	+11.8	3.9	-35.0	25.7	-23.8
PBZ 500ppm	1166.3	+38.4	3836.8	+54.3	86.5	-38.6	45.0	-39.1	1252.8	+27.4	3881.8	+51.6	13.5	+125.0	85.3	+153.
PBZ 1000ppm	1023.4	+21.4	3550.8	+42.8	98.4	-30.1	39.0	-47.2	1121.8	+14 1	3589.8	+40.2	18.4	+73.3	91.0	+170.
Urea 1%	682 6	-19.0	2227.9	-10 4	175.2	+24.5	90.8	+23.0	857.8	-12.8	2318.7	-9.5	3.9	-35.0	24.5	-273.
GA_3 10 ppm + urea1%	825.8	-2.0	2513.3	+1.0	181.1	+24.7	103.3	+39.3	1006.9	+2.4	2616.6	+2.2	4.6	-23.4	24.3	-27.9
GA_3 20 ppm + urea1%	778.7	-7.6	2419.8	-2.7	192.9	+37.1	117.0	+59.5	971.6	-1.2	2536.8	-0.9	4.0	-33.3	20 7	-38 6
PBZ 500 ppm + urea 1%	1230.6	+46.0	4205.1	+69.1	177 4	+26.0	48.9	-32 8	1408.0	+43.2	4254.0	+66 1	6.9	+15.0	86.0	+155.1
PBZ 1000 ppm + urea 1%	1134.8	+34.7	4116.8	+65.5	163.6	+16.2	41.1	-44 4	1298.4	+32.0	4157.9	+62.4	6.9	+15.0	100.2	+197.3
L.S.D. 0.05	65.72	-	193.1	-	23.60	-	17.9	-	88.25	-	213.3	-	4.34	-	10.4	-

* Increase/ or decrease in relation to control.

3. Number of male & perfect flowers, total number of flowers/ panicle and sex ratio

The number of male flowers per one healthy panicle (Tables 3, 4) ranged from 682.6 to 1230.6 in the first season and from 711.0 to 1259.9 in the second season, according to tested treatment. The corresponding values for the malformed panicle were : 2227.9-4205.1 in the first season and 2183.4 - 4129.3 in the second season , according to treatment. As such, the malformed panicles bore about three folds the numbers of male flowers or healthy panicles.

The treatments that significantly increased number of male flowers on healthy and malformed panicles were PBZ 500 & 1000 ppm and PBZ 500 & 1000 ppm + urea) . In addition, GA_3 at 10 & 20 ppm also increased number of male flowers, but on malformed panicles only. On the contrary , urea (alone) depressed numbers of male flowers on both healthy and malformed panicles as compared to the control. The other tested treatment (i.e. GA_3 10 & 20 ppm alone for healthy panicles and GA_3 10 & 20 ppm + urea for both healthy and malformed panicles) failed to induce significant effect on number of male flowers per panicle.

The number of perfect flowers per one healthy panicle, generally, ranged from 86.5 to 204.7 in the first season and from 94.9 to 233.1 in the second season according to treatment. The corresponding values for malformed panicles were: 39.0 - 117.0 in the first season and 32.0-116.0 in the second season. Thus, the numbers of perfect flowers on malformed panicles were about one third those on healthy panicles.

The tested treatments significantly affected the number of perfect flowers per panicle in both seasons, the treatments implying GA_3 and urea clearly increased numbers of perfect flowers on both healthy and malformed panicles. The increments of perfect flowers on healthy panicles attained 40.2 & 45.7% in the two seasons with GA_3 10 ppm (alone) and 54.4 & 43.4% with GA_3 at 20 ppm (alone) compared to the control. Considerable increments in number of perfect flowers were also noticed on the malformed panicles by the same treatments . On the contrary, PBZ (alone), particularly at the higher concentration (1000 ppm) obviously depressed number of perfect flowers on both healthy and malformed panicles. Such reduction reached 47.2 & 43.2% in the two seasons compared to the control. The combined treatments of (PBZ + urea) induced moderate increments in number of perfect flowers on healthy panicles, while decreased perfect flowers on malformed panicles particularly in the first season.

The total number of flowers on both healthy and malformed panicles was significantly increased by all treatments implying PBZ, i.e. PBZ (alone) at 500 & 1000 ppm and (PBZ 500 & 1000 ppm + urea). This was apparently due to the great increase in number of male flowers induced by PBZ . The highest increments, however, came from the combined treatments (PBZ 500 & 1000 ppm + urea) for malformed panicles which reached 66.1 & 52.1% over the control in the two seasons for the treatment (PBZ 500 ppm + urea) and 62.4 & 49.9% for the treatment (PBZ 1000 ppm + urea).

Table (4) Effect of some GA_3 , PBZ and urea foliar spray treatments on numbers of male & perfect flowers, total number of flowers and sex ratio on healthy and malformed Alphonse mango panicles (second season, 2002/ 2003)

Foliar spray treatments	Male flowers				Perfect flowers				Total				Sex ratio (male / perfect)			
	Healthy		Malformed		Healthy		Malformed		Healthy		Malformed		Healthy		Malformed	
	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%	No.	*+/-%
Cont (water)	862.9	-	2695 0	-	156.5	-	56.3	-	1019 4	-	2751.3	-	5.5	-	47.9	-
GA_3 10 ppm	859.4	-0.5	2944.7	+9.2	228.1	+45.2	98.9	+75.6	1087.5	+6.6	3043.6	+10.6	3.8	-31.0	29.8	-37.
GA_3 20 ppm	831 1	-3.7	2747.7	+1.9	224.5	+43.4	100.8	+79.0	1055.6	+3.5	2848.5	+3 5	3.7	-32 8	27.3	-43.
PBZ 500ppm	1259 9	+46.0	4004.0	+48.5	94.9	-39.4	58.0	+3.0	1354.8	+32.9	4062.0	+47.6	13.3	+141 8	69 0	+44.
PBZ 1000ppm	1048 1	+21.4	3702.1	+37.3	117.3	-25.1	32.0	-43.2	1165.4	+14.3	3734.1	+35 7	8.9	+61.8	115.7	+141
Urea 1%	711.0	-17 7	2183.4	-19.0	195.8	+25.1	77 6	+37.8	906.8	-11.1	2261.0	-17.9	3.6	-34.6	28.1	-41.0
GA_3 10 ppm + urea1%	852.0	-1.3	2650.8	-1.7	208.1	+32.9	116.0	+166 0	1060.1	+3.9	2766.8	+0.5	4.1	-25.5	22.9	-52.
GA_3 20 ppm + urea1%	814.8	-5.6	2713.9	+0.7	233.1	+48.9	115.0	+104.2	1047.9	+2.7	2828.9	+2.8	3 5	-36.4	23 6	-50
PBZ 500 ppm + urea 1%	1247.7	+44.5	4129.3	+53..2	190.1	+21.4	56.0	-0.6	1437.8	+41.0	4185.3	+52.1	6.6	+28.0	73 7	+53.
PBZ 1000 ppm + urea 1%	1146.0	+32.8	4074.2	+51 1	185.1	+18.2	51.9	-7.9	1331.1	+30.5	4126.1	+49.9	6.2	+12.7	78 5	+63
L.S.D. 0.05	71.33	-	206.2	-	22.16	-	16.5	-	97.77	-	222.7	-	3.27	-	12.8	-

* Increase/ or decrease in relation to control.

Table (5) Effect of some GA_3 , PBZ and urea foliar spray treatments on panicles length and panicle diameter per healthy and malformed panicles of Alphonse mango tree (2001 / 2002 and 2002 / 2003 seasons).

Foliar spray treatments	Panicles length (cm)								Panicle diameter at the base (cm)							
	Healthy				Malformed				Healthy				Malformed			
	2001/2002		2002/2003		2001/2002		2002/2003		2001/2002		2002/2003		2001/2002		2002/2003	
	cm	*+/-%	Cm	*+/-%	cm	*+/-%	cm	*+/-%	cm	*+/-%	cm	*+/-%	cm	*+/-%	cm	*+/-%
Cont (water)	19.6	-	20.5	-	12.7	-	11.5	-	13.9	-	14.9	-	13.2	-	11.8	-
GA_3 10 ppm	22.0	+12.2	23.6	+15.1	13.8	+8.6	11.6	+0.8	14.5	+4.3	15.6	+4.6	14.2	+7.5	12.0	+1 6
GA_3 20 ppm	23.8	+21.4	24.9	+21.4	14.6	+14.9	11.9	+3.4	15.4	+10.7	16.1	+8.0	15.0	+13.6	12.5	+5.9
PBZ 500ppm	18.2	-7.2	19.1	-6.9	11.5	-9.5	11.3	-1.8	13.3	-4 4	13.9	-6.8	11.9	-9.9	11.5	-2.6
PBZ 1000ppm	16.8	-14.3	17.7	-13.7	10.3	-18.9	11.0	-4 4	12.1	-13.0	12.7	-14.8	10.6	-19.7	11.3	-4.3
Urea 1%	22.9	+10.8	23.2	+13.3	13.5	+6.2	12.2	+6.0	14.1	+1.4	14.8	-0 7	14.5	+9.8	12.7	+7.6
GA_3 10 ppm + urea1%	25.2	+28.3	26.8	+30.7	14.6	+14.9	12.8	+11.3	16.2	+16.5	17.9	+20.1	15.1	+14.3	13.0	+10.1
GA_3 20 ppm + urea1%	27.6	+40.8	28.3	+38.0	16.9	+33.0	13.2	+13.0	17.1	+23.0	18.3	+22.8	17.3	+31.0	13.5	+14.4
PBZ 500 ppm + urea 1%	20.2	+3.0	21.8	+6.3	13.0	+2.3	11.9	+3.4	14.1	+1.4	15.2	+2.0	13.3	+0.3	12.3	+4.2
PBZ 1000 ppm + urea 1%	18.7	-4.6	19.3	-5.9	12.5	-1.6	11.4	-0.9	12.7	-8.7	13.4	-10.1	12.8	-3.1	11.8	+0.0
L.S.D. 0.05	3.51	-	3.77	-	2.68	-	1.15	-	2.07	-	2.73	-	3.01	-	1.20	-

* Increase/ or decrease in relation to control.

In addition, GA_3 (alone) at both tested concentrations also increased total number of flowers, but on malformed panicles only. On the contrary , urea (alone) significantly depressed total number of flowers on both healthy and malformed panicles, which was apparently due to parallel reductions in number of male flowers. The urea - induced reduction in total number of flowers reached 12.8 & 11.1% for healthy panicles and 9.5 & 17.9% for malformed panicles in the first & second seasons, respectively.

The sex ratio (male / perfect) was significantly increased by PBZ (alone) at both tested concentrations and on both healthy and malformed panicles. On healthy panicles , the increments were 125.0 & 141.8% over the control in the two seasons with the concentration of 500 ppm, and were 73.3 & 61.8% over the conrol with the concentration of 1000 ppm. The combined treatments (PBZ 500 & 1000 ppm + urea) also increased sex ratio , but only on the malformed panicles . With GA_3 treatments (10 & 20 ppm, alone or with urea) , depressions of the sex ratio were observed only on the malformed panicles . Such reductions were more obvious in the second season.

The reduction in perfect flowers and the increment in male flowers on malformed panicles as compared with healthy ones was in agreement with Dahshan, (1987).

The increase in number of perfect flowers by GA_3 treatments confirmed the results of Rajput and Singh (1989) who reported that two GA_3 foliar sprays (on 5 & 20 Jan.) on Dashehari mango trees depressed the sex ratio (male / perfect flowers) on the panicles. On the contrary, Utsunomiya *et al.*, (1995) found that GA_3 spray at 50 ppm on Irwin mango trees decreased number of perfect flowers on the panicles.

Regarding the effect of PBZ treatments, the obtained herein results contradicted those reported by Burondkar *et al.* (1997) who found that PBZ soil application at 7.5 g/ tree to Alphonse mango trees increased number of perfect flowers on the panicles . Also Zora *et al.* (2000) reported that soil application of PBZ (10 - 60 g/ tree) to Dusehri mango trees in Oct. prior to flower-bud-differentiation increased number of perfect flowers on the panicles. Such contradiction might be due to varietal differences and / or to the difference in method of application since the applied 4 foliar sprays in the present work might have more obvious effect on the hormonal balance in buds than did the single soil application.

As for urea effect on number of perfect and male flowers/ panicle, Shabaan (1987) found that spraying urea (0.5-1.5%) on Hindy Be-Sinnara mango trees increased total number of flowers and number of perfect flowers per panicle. The percentage of perfect flowers attained 24.20 & 23.49% with 1.5% urea spray against 17.16 & 20.62% for the control in the 1st and 2nd seasons, respectively.

4.Panicle length and diameter

The data in Table (5) clear that healthy panicles were always longer and narrower than malformed ones .Regarding the length of healthy panicles, only three treatments gave significant increase over the control, those were GA_3 20 ppm (alone), (GA_3 10 ppm + urea) and (GA_3 20 ppm + urea). The

increments by those treatments were 23.8, 25.2 & 27.6% respectively over the control in the first season and 21.4, 30.7 & 38% , respectively, in the second season . Meanwhile the diameter of the healthy panicle was increased only by the combined treatment (GA_3 20 ppm + urea) ; the increments were 33 & 31% over the control in the first and second seasons, respectively.

5.Differences between healthy and malformed panicles in some chemical constituents

The data in Table (6) obviously show the higher contents of total phenols, total free amino acids, endogenous IAA and ABA in malformed panicles as compared with healthy ones. On the other hand, the malformed panicles revealed lower contents of total indoles and endogenous gibberellins in comparison with healthy ones.

The higher phenols content in malformed panicles than in healthy ones was in agreement with El-Ghandour *et al.* (1976) and Singh and Dhillon, (1993). However, Stino *et al.* (1981) and Ebeed (1989) found that total phenols content was higher in healthy panicles rather than in malformed ones. Also, Bastawros, (1986) reported that total phenols content was higher in panicles of varieties resistant to malformation than in those of susceptible ones.

The higher endogenous IAA content in malformed panicles was in line with Dahshan, (1987), Mishra and Dhillon, (1978) and Haggag (1986). However, the opposite (i.e. lower IAA in malformed panicles) was reported by Dhillon and Singh , (1989) , Singh and Dhillon, (1990) and Zora *et al.* , (2000).

Table (6) Differences between healthy and malformed panicles of Alphonse mango in some chemical constituents (2001 / 2002 and 2002 / 2003 seasons).

Constituents	2001/2002			2002/2003		
	Healthy	Malformed		Healthy	Malformed	
	Content	Content	-+/-%	Content	Content	-+/-%
Total phenols (mg/g d..w)	13.50	19.60	+45.1	15.36	21.40	+39 3
Total indoles (mg/d..w)	0.31	0.21	-32.3	0.25	0.17	-32.0
Total free amino acids (mg/d.w)	1.99	2.66	+33.6	1.65	2.80	+69.6
Endogenous GA_3 (mg/100 g.d.w)	111.00	70.00	-37.0	139.00	62.00	-55.4
Endogenous IAA (mg/100g d.w.)	11.00	34.00	+209.0	13.00	40.00	+207 6
Endogenous ABA (mg/100g d.w.)	3.50	18.00	+414.2	4.50	12.00	+166.6

The higher ABA content in malformed panicles was in accordance with Haggag, (1986), Singh and Dhillon (1990), Singh and Dhillon, (1991) and Singh (2000) . In this respect , Singh and Dhillon, (1991) suggested that higher ABA level in malformed panicles inhibited their apical growth, which was the reason of their bunchy - top appearance. However, contradicting results were reported by Mishra and Dhillon, (1978) who found that malformed panicles revealed lower ABA level than healthy ones.

Also, the higher total free amino acids content in malformed panicles agreed with Singh and Dhillon (1989-a & b) but contradicted with another report of the same authors (Singh and Dhillon, 1993).

The lower endogenous GA_3 level in malformed panicles compared with healthy ones was in line with Haggag, (1986) and Raafat *et al.* (1995) while contradicted with Abou -Hussein *et al.* (1975) who suggested that malformed panicles contain higher endogenous GA_3 which is responsible for increasing the growth of those panicles and the increase in number of male flowers. In addition. Dahshan (1987), Singh and Dhillon (1990) and Zora *et al.* (2000) also found higher levels of endogenous GA_3 in malformed panicles rather than in healthy ones.

The abovementioned contra-dictions among the available literature reports concerning the differences in endogenous constituents between malformed and healthy panicles may suggest that these constituents are resultants of the interaction between genetical (varietal), environmental factors and the causality of this disorder.

Generally , results of the present work indicated the better response of Alphonse mango trees to the combined treatment of (GA_3 20 ppm + urea 1%) which delayed first panicle emergence by 6 & 11 days , first flowering by 9 & 15 days and first fruit set by 10 & 14 days compared to the control in the first & second seasons, respectively. In addition, the treatments of (GA_3 20 ppm + urea 1%) and GA_3 20 ppm (alone) clearly increased total number of panicles and number of healthy panicles per tree as compared to control, while obviously depressed number of malformed panicles / tree and the malformation percentage.

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خواص الشماريخ الزهريه للأشجار البالغه من المانجو صنف الفونس وتأثرها ببعض معاملات اليوريا وحمض الجبرليك والكلتار اثناء الخريف والشتاء.

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أجريت هذه الدراسة فى موسمين متتالين (٢٠٠١/٢٠٠٢،٢٠٠٢/٢٠٠٣) على أشجار مانجو بالغه صنف الفونس حيث تم رش الأشجار أربع مرات على فترات شهرية من منتصف أكتوبر حتى منتصف يناير . وقد تم اختبار عشر معاملات هي: المقارنة (الرش بالماء)، GA_3 بمفرده بتركيز ١٠جزء فى المليون ،GA_3 بمفرده بتركيز ٢٠جزء فى المليون، كلتار (PBZ) بمفرده بتركيز ٥٠٠جزءفى المليون ، كلتار بمفرده بتركيز ١٠٠٠جزء فى المليون ،يوريا منفردة بتركيز ١% ، GA_3 بتركيز ١٠جزء من المليون + يوريا ١% ، GA_3 بتركيز ٢٠جزء فى المليون + يوريا ١%، كلتار بتركيز ٥٠٠جزء فى المليون +يوريا ١%، كلتار بتركيز ١٠٠٠ جزء فى المليون +يوريا ١%، .

وقد نتج من استخدام GA_3 – بأى من التركيزين المختبرين وسواء مع اليوريا او بدونها – تأخير بزوغ الشماريخ الزهرية وكذلك التزهير وعقد الثمار ، بالإضافة إلى زيادة عدد الأزهار الخنثى بالشمراخ وطول الشمراخ. كما أدت نفس المعاملات إلى زيادة فى عدد الشماريخ السليمة والعدد الكلى للشماريخ/ الشجرة بينما قللت عدد الشماريخ الزهرية المشوهه والنسبة المئوية للتشوة الزهرى بدرجة كبيرة. أما المعاملات المحتوية على كلتار – باى من التركيزين المختبرين وسواء مع اليوريا أو بدونها- فقد سببت تبكير بزوغ الشماريخ الزهرية والتزهير وعقد الثمار. كما أدت هذه المعاملات إلى زيادة عدد الشماريخ / شجرة مع زيادة عدد الشماريخ المشوهه والنسبة المئوية للتشوه الزهرى. كما سببت المعاملات المحتوية على كلتار – خاصة فى التركيز الأعلى (١٠٠٠ جزء فى المليون) زيادة كبيرة فى عدد الأزهار المذكرة والعدد الكلى للازهار بالشمراخ مع زيادة النسبة الجنسية (الأزهار المذكرة: الخنثى).

وتبين من تحليل الشماريخ الزهرية السليمة والمشوهه (فى أشجار المقارنة) زيادة محتوى الفينولات الكلية والأحماض الأمينية الحرة الكلية واندول حمض الخليك وحمض الأبسيسيك فى الشماريخ المشوهه مقارنة بالشماريخ السليمة. وعلى العكس كان محتوى الشماريخ المشوهه من الاندولات الكلية والجبرلين أقل من محتوى الشماريخ السليمة.