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EFFECT OF GA3, HAND POLLINATION AND BRANCH-BENDING ON PRODUCTIVITY AND QUALITY OF BANATI GUAVA TREES GROWN IN SANDY SOILS.

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ABSTRACT

This study was carried out during two successive seasons (2010 and 2011) on fourteen years old Banati guava trees (*Psidium guajava* L.), grown in sandy soil in the South of Tahrir region at Aly Mubarak Research Station. GA3 at 300 or 400 and 500 ppm was sprayed once time at full bloom, hand pollination with pollens from Malizi and Gizi guava trees for Banati guava trees as well as branches bending were carried out. The obtained results revealed that most treatments especially those included GA3 sprays improved the yield and fruit quality. However data proved that GA3 sprays at 400 ppm were more effective in increasing number of fruit set/ meter and fruit set and subsequently improved the yield as well as the physical fruit characteristics. Hand pollination with pollens from Malizi guava tree for Banati guava trees significantly increased total acidity and Vitamin C. Branches bending had the highest percentage of total sugars. So, spraying 400 ppm GA3 one time at full bloom was the promising treatment for increasing productivity of low yield Banati guava trees grown under sandy soil condition.

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the important tropical fruit crop grown throughout the tropical and sub-tropical areas. It is a hardy, prolific bearer and highly remunerative fruit crop and also can be grown satisfactorily even in adverse soil and climatic conditions. The area and production of guava is increasing worldwide and widely processed in many parts of the world. Guava is a good source of energy (51 calories/100 g edible portions), vitamins, and minerals (Mitra & Sanyal, 2004). In Egypt, guava is considered one of the most important fruit crop either for local consumption or export demands. Guava acreage reached 39664 feddans with total productivity of 330791 tons according to the statistics of the Ministry of Agricultural (2007). Banati guava (seedless) have low yield especially when planting in the newly reclaimed lands.This may be due to inadequate fruit set and sever fruit drop which represent the major causes of low yield. The beneficial effect of GA3 on yield and fruit quality of fruit crops were mentioned by many investigators as El- Sharkawy & Mehiesen (2005)on guava, Agusti *et al.*,(1982); Abd El-Migeed (2002) and Sayed *et al.*, (2004); Eman et al., 2007 on oranges, El Sese *et al.*, (2005) on mandarin, Mostafa *et al.* (2001) ; Zhang et al., 2007 on pear. They found that, GA 3 whether, applied at full bloom or small fruit stage has significantly increased the number of the harvested fruits. Also, the use of GA as a growth regulator to promote size and to control fruit drops which may be due to their ability to increase cell enlargement (Arteca, 1996 and Davis, 2004).

The effects of hand pollination technique, pollen source and the time of pollination were evaluated on the set and development fruit reflected on the yield (Richardson & Anderso, 1996). Under cross-pollination conditions a positive correlation was found between yield and number of fruits per tree (Schneider, *et al.*, 2009).

As tree management strategy to increase shoot numbers and induce off-season flowering, farmers often resort to bending the shoots. Bending induces profuse flowering and fruiting, as well as fetches greater returns (Ghosh, 2003) and regulate flowering by bending of shoots (Mitra, *et al.*, 2008). Bending consistently increased the lipid, tryptophan, proline, polyphenol oxidase, catalase, and peroxidase levels in leaves, bark, and fruits, but decreased phenolics. These changes may have resulted in greater flowering and fruiting, giving rise to higher yield (Praagh and Hauschildt 1991on apple and pear; Sarkar,*et al.*,2005 and Bagchi,*et al.*, 2008 on guava).

Accordingly, this work was planned as a traid to overcome the problem of low yield of Banati guava trees grown under sandy soil conditions through studying the influence of spraying GA3, hand pollination and branches bending on fruit set, yield and fruit quality.

MATERIALS AND METHODS

This study was conducted in two consecutive growing seasons 2010 and 2011 on 14 years old (in the beginning of study) Banati guava trees planted in the South of Tahrir region at Aly Mubarak Research Station whereas the decrease of Banati guava trees productivity is apparent in this area. These trees were uniform in shape and size as possible, planted at 5 X 5 meters apart, and grown in sandy soil irrigated from the Nile water (El-Nassr canal). This study aimed to improve the productivity of Banati guava trees using application of GA3, hand pollination and branch-pending method. The experiment was set in a complete randomized design with eight treatments each contains three replicates and the replicate represented by two Banati guava trees. The normal horticultural practices that used in the farm were applied to all Banati guava trees except those dealing with the treatments.

The eight treatments evolved in this investigation were outlined as follows:

1) Control.
2) Spraying GA3 at 500 ppm.
3) Spraying GA3 at 400 ppm.
4) Spraying GA3 at 300 ppm
5) Bagging) Hand pollination with Malizi guava pollen grains.
7) Hand pollination with Gizi guava pollen grains.
8) Branches pending.

For control treatment trees were left under the natural conditions without any treatments.

For spraying GA3 treatments all the flowers of Banati guava treated trees were sprayed at different concentrations of GA3 at the full bloom stage in 28 March in the first season and in 4 April in the second season.

For bagging treatment all the flowers of Banati guava treated trees were covered with cloth bags before the full bloom stage between second weeks of March tell second weeks of April in the first season and between14 March till 14 April in the second season.

For hand pollination treatments all the flowers of Banati guava treated trees were emasculated and pollinated manually with the pollen grains which harvested from the pollinator trees then covered with cloth bags at the full bloom stage in 28 March in the first season and in 4 April in the second season.

For branches pending treatment all of the main branches of the tested trees were tailed and fixed by stones in the land from the beginning of March tell the end of the study during both seasons.

The flowers of all treated trees were calculated in the full bloom stage and treated by the different above treatments.

The following parameters were determined:

Fruit set and yield:

Fruit set of Banati guava trees was counted and recorded 15 days after full bloom date in both seasons.

Mature fruits from the guava trees under study were collected in 18 August in 2010 season and in 25 August in 2011 season to study the fruit characteristics and weighted to record the yield of each treatment.

Fruit characteristics:

In each fruit sample, the average fruit weight, fruit length, fruit diameter and flesh thickness were measured.

Fruit chemical characteristics:

1) Total soluble solids percentage (TSS %) was determined by hand refractmeter (RR12-Nr05175).
2) Total acidity percentage (%) was determined by titration as described by (A.O.A.C., 1985) in grams of citric acid per 100 ml juice.
3) Vit. C content (mg. ascorbic acid / 100 ml juice) by A.O.A.C., (1985).
4) Total soluble sugars were determined according to Smith *et al.*, (1956).

Statistical analysis:

The complete randomized design was followed in this study. The obtained data was subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1980). Differences between treatments were compared by LSD test at 5%.

RESULTS AND DISCUSSION

Effect of GA3, hand pollination and branch-pending on fruit set and yield:

Fruit set: Data in Table (1) clearly show that spraying GA3 at 300 to 500 ppm , using hand pollination with Malizi or Gizi guava and branch bending significantly increased number of fruit set / meter and percentage of fruit set compared with the control treatment. The increase was associated with the increase in GA3 concentration. The highest number of fruit set / meter (20.83 and 23.34) and highest fruit set % (86.96 and 88.46 %) obtained for trees

treated with GA3 at 400 ppm during both seasons, respectively. In this respect, the differences between spraying GA3 at 400 and 500 ppm treatments were not significant in both seasons. Hand pollination for Banati guava with pollens from Gizi guava trees was better than pollens from Malizi guava trees. On the other hand, bagging treatment gave the lowest values of number of fruit set / meter (11.12 and 12.06) and percentage of fruit set (54.51 and 54.17) in both seasons, respectively and less than the control trees.

The obtained results proved that spraying GA3 at 400 and 500 ppm has a positive effect on increasing fruit set. In this respect, many investigators noticed that exogenous application of gibberellins was effective in increasing fruit set of guava trees El–Sharkawy &Mehaisen, (2005).The obtained results are in harmony with the findings obtained by Agusti *et al.*, (2000) who proved that GA 3 sprays at petal fall enhanced fruit set of Sweet orange tree. Also, the present results were supported by El Sese (2005) on Balady mandarin.

Similarly, the obtained results are in agreement with Praagh, and Hauschildt (1991) on young "Cox" trees, Sharma *et al.*, (2011) on guava who found that hand pollination significantly increased fruit set percentage and bending, Goldschmidt-Reischel (1997) on apple and pear who reported that bending shoots improved the fruit set.

Yield per tree (kg): Table (1) showed that average yield per tree (kg) significantly increased by using all studied treatments except bagging treatment as the average yield decreased under the control in both seasons. Application of GA3 was favorable in improving the yield than hand pollination and bending. Foliar application of GA3 at 400 ppm, GA3 at 500 ppm, 300 ppm, branches bending and hand pollination with pollens of Gizi guava trees in descending order obviously achieved the highest yield. The maximum yield was recorded in the trees received foliar application of GA3 at 400 ppm. Under such promising treatment the tree yielded 13.11 and 14.12 kg. / tree in both seasons, respectively. On contrary, the lowest yield recorded for trees bagging flowers (5.54 and 5.50 kg) and untreated trees (6.32 and 6.53 kg) in both seasons, respectively and no differences between them.

Table 1: Effect of GA3, hand pollination and branch-bending on fruit set and yield of Banati guava trees during 2010 and 2011 seasons.

Treatments	No. of fruit set / m		Fruit set %		Yield (kg\tree)	
	2010	2011	2010	2011	2010	2011
Control	11.56	12.75	61.55	57.13	6.32	6.53
Spraying GA3 at 500 ppm	19.59	22.54	86.36	88.11	12.51	13.54
Spraying GA3 at 400 ppm	20.83	23.34	86.96	88.46	13.11	14.12
Spraying GA3 at 300 ppm	14.85	17.64	82.35	80.95	11.24	9.54
Bagging	11.12	12.06	54.51	54.17	5.54	5.50
Pollination with Malizi guava	14.75	16.52	73.68	76.19	7.23	7.56
Pollination with Gizi guava	16.66	18.38	80.16	78.26	9.11	8.62
Branch bending	12.67	15.58	80.09	78.95	9.61	8.71
L.S.D. at 5% level	1.42	2.28	3.14	2.93	1.74	1.82

The obtained results of GA3 sprays are in line with those reported by El- Sharkawy and Mehaisen (2005) on guava and El-Sese (2005) who found that Balady mandarin trees sprayed at full bloom with GA3 resulted in increased yield of fruits/ tree. The obtained results also supported by Agusti *et al.*, (2000) on Sweet orange, Mostafa *et al.*,are (2001) on pear, Abd El-Migeed (2002) on Washington navel and Ramezani and Shekafandeh,(2009) on olive. Increasing yield due to GA3 may be attributed to its effect on increasing levels of IAA. It could be concluded that the enhancement previously mentioned in yield may be attributed to the improvement in the nutritional status and activation cell division by stimulating the synthesis of cytokinins and auxin (Marschner, 1986; Boonkorkaew *et al.*, 2008).

Similarly the present results were supported by the findings obtained by Praagh and Hauschildt (1991) on young "Cox" orange trees, Sarkar, *et al.*, (2005); and Sharma *et al.*, (2011) on guava who worked on pollination. Goldschmidt-Reischel (1997) on apple and pear and Sarkar and Ghosh (2006) reported that bending of shoots increased the yield of guava trees. Bending management increased the lipid, tryptophan, proline, polyphenol oxidase, catalase, and peroxidase levels in leaves such biomolecular changes within the guava shoots may have resulted in greater flowering and fruiting, giving rise to higher yield per plant (Bagchi *et al.*,2008).

Effect of GA3, hand pollination and branch-pending on fruit dimensions and weight:

Fruit dimensions: It is evident from Table (2) that fruit length , diameter and flesh thickness were significantly increased as result of using GA3, hand pollination and branch-bending compared with the check treatment in both seasons. Spraying of GA3 was favourable in improving fruit dimensions and flesh thickness than using hand pollination with pollens from Malizi or Gizi and branches bending. The maximum values were detected on the trees sprayed with GA3 at 400 ppm. On the other hand, bagging treatment had the lowest values in both seasons. Concerning branches bending treatment, it had the best values compared with pollination treatments and control during both seasons.

The beneficial effect of GA3 on fruit dimensions was emphasized by the results of El- Sharkawy and Mehiesen (2005) on guava; Eman *et al.*, (2007) on citrus and Rizk-Alla, *et al.*, (2011) on grapes.

The effect of hand pollination and bending on improving fruit dimensions was confirmed by the results of Singh & Singh,(2001) and Sharma *et al.*, (2011) on guava.

Fruit weight: It can be stated from the obtained data in Table (2) that foliar application of different concentrations of GA3, using of Malizi or Gizi as a pollinators for Banati guava trees and branches bending significantly increased average fruit weight as compared with the untreated trees.

Foliar application of GA3 at 400 ppm was the superior treatment in this respect and values were 131.58 and 137.87 gm. followed by GA3 at 500 ppm and values were 129.64 and 133.24 gm. in both seasons, respectively and no significant differences between them. Bagging treatment gave the lowest values (101.12 and 105.24 gm.)except the control in both seasons,

respectively. Branches bending gave better results in this concern comparing with the hand pollination treatments and control in both seasons.

El- Sharkawy & Mehiesen (2005) on guava and Eman *et al.*, (2007) on citrus supported the beneficial effect of gibberellins on fruit weight.

The improving influence of hand pollination and branches bending in this respect was reported by Richardson & Anderson (1996) on cherimoya, Singh & Singh,(2006) on citrus and Sharma *et al.*, (2011) on guava.

From the obtained results it seems that physical fruit properties in terms of fruit weight, fruit length and diameter was improved by most treatments specially those owned GA3 sprays. Fruit weight and size increased in response to exogenously applied GA3 and this has been associated with an increase in levels of IAA consequently cell elongation and cell enlargement (Pharis and King 1995 and Boonkorkaew *et al.*, 2008) consequently increase in cell size of the mesocarp and increased sink demand (Zhang *et al.*, 2007; Brenner and Cheikh, 1995). GA3 increase sink demand by the enhancement of phloem unloading or/and metabolism of carbon assimilates in fruit. GA3 treatment significantly increased fruit size and fruit fresh weight. A larger fruit size and increased sink demand were closely correlated with changes in activities of sugar metabolizing enzymes induced by GA3 application.

However, the present results are supported by the findings obtained by Sayed *et al.*, (2004) who found that fruit weight, fruit length and fruit diameter of Valencia orange were increased due to GA3 sprays.

Table 2: Effect of GA3, hand pollination and branch-bending on fruit characteristics of Banati guava trees during 2010 and 2011 seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)		Flesh thickness (mm)		Fruit weight (gm)	
	2010	2011	2010	2011	2010	2011	2010	2011
Control	4.51	4.64	4.61	4.73	16.09	17.54	99.50	102.10
Spraying GA3 at500ppm	8.29	8.33	8.40	8.42	32.13	34.64	129.64	133.24
Spraying GA3 at400ppm	8.46	8.65	8.49	8.75	33.67	35.19	131.58	137.87
Spraying GA3 at300ppm	7.53	7.72	7.61	7.84	29.62	30.41	123.35	128.65
Bagging	4.73	4.86	4.86	4.96	18.12	18.38	101.12	105.24
Pollination with Malizi guava	5.90	6.12	6.11	6.15	21.32	22.29	108.21	110.12
Pollination with Gizi guava	6.74	6.84	6.93	7.14	24.51	25.40	113.51	116.65
Branch bending	7.25	7.31	7.32	7.42	26.39	27.25	119.67	123.56
L.S.D. at 5% level	**0.63**	**0.36**	**0.54**	**0.46**	**2.13**	**2.80**	**3.26**	**4.75**

Effect of GA3, hand pollination and branch-pending on Fruit chemical characteristics:

Total soluble solids (TSS %): It is clear from data in Table (3) that the values of TSS % were significantly affected compared with the control in both seasons by foliar sprays of GA3 at different used concentrations, hand pollination and branches bending during both seasons. Application of GA3 at 400 ppm gave the highest TSS percentage (11.66 and 11.92%) followed by GA3 at 500 ppm (11.53 and 11.81%)in both seasons, respectively where the

differences between them were not significant. Bagging treatment gave the lowest values (9.42 and 9.50 %) in both seasons, respectively.

Total acidity and TSS/ Acid ratio:

Results in Table (3) indicated that total fruit acidity percentage was affected significantly by different used treatments in both seasons. The lowest values were recorded for fruits of trees treated with GA3 at 400 ppm (0.281 and 0.295 %) followed by that of treated with branches bending (0.286 and 0.301 %) in both seasons, respectively. On the other hand, the highest percentage values obtained with fruits of trees were pollinated with pollens from Malizi guava trees (0.382 and 0.426 %) followed by that pollinated with pollens from Gizi guava trees (0.353 and 0.372 %) in both seasons, respectively.

Concerning the TSS / acid ratio, it was affected significantly by application of GA3, hand pollination and branches bending in both seasons. Spraying with GA3 at 400 ppm gave the highest ratio (41.50 and 40.41) followed by that branches were bended (39.93 and 37.81) in both seasons, respectively. Hand pollination of Banati guava trees with pollens of Malizi and Gizi guava trees as well as bagging gave the values less than the control treatment in both seasons.

Vitamin C (mg / 100 ml juice):

Vitamin C content was significantly increased by different treatments under study during both seasons as shown in Table (3). The best result was obtained with hand pollination pollens from Malizi guava trees treatment (162.25 and 167.39) as the increase in vitamin C content was significantly higher than other treatments in both seasons, while vitamin C content significantly decreased in fruits of untreated trees (101.02 and 106.22) in both seasons, respectively.

Total sugars percentage:

Data in Table (3) indicated that fruit content of total sugars percentage was affected significantly by application of GA3, hand pollination and branches bending in both seasons. Branches bending treatment gave the highest fruit content of total sugars percentage (0.73 and 0.81 %) followed by that owned hand pollination with Gizi guava trees (0.69 and 0.73 %) while the lowest values (0.42 and 0.44%) were recorded for the check treatment in both seasons, respectively.

These results are in harmony with those obtained by Assy *et al.*, (1988), Chang and Lin (2006) on citrus. Mostafa, *et al.*,(2001) and Zhang *et al.*, 2007 on pear, Ghosh, 2003 and Bagchi *et al.*, 2008 on guava. They found that application of GA3 improved the fruit chemical characteristics which may be due to its role in enhancement the nutritional status reflected on yield and fruit quality (Najjar, 1985).

Kuiper (1993) suggested that sink strength is established and regulated by plant growth regulators .Certain plant hormones can increase mobilization of assimilates to fruit and modulate many of the rate-limiting components in carbon partitioning (Ozga & Dennis, 2003). These hormones may stimulate transport of nutrients through the phloem, modify the strength of the sink by stimulating its growth and increase the ability for sugar unloading from the

phloem. Or, they may act on metabolism and compartmentalization of sugar and its metabolites (Brenner & Cheikh, 1995).

Hand pollination with pollens from Malizi and Gizi guava trees improved the fruit quality, these results go in the same line with Praagh and

Hauschildt (1991) on young "Cox" orange trees, who worked on pollination.

Singh & Singh (2001) reported that fully orange fruit from bent branches were small and had low TSS: acid ratios in comparison with green fruit in straight branches.

Table 3: Effect of GA3, hand pollination and branch-bending on Fruit chemical characteristics of Banati guava trees during 2010 and 2011 seasons.

Treatments	TSS %		Acidity %		TSS/Acid ratio		Vit. C (mg/100ml)		Total sugars (%)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Control	9.34	9.41	0.292	0.317	32.00	29.69	101.02	106.22	0.42	0.44
Spraying GA3 at 500ppm	11.53	11.81	0.313	0.310	36.84	38.10	104.65	107.26	0.48	0.47
Spraying GA3 at 400ppm	11.66	11.92	0.281	0.295	41.50	40.41	108.48	112.60	0.51	0.55
Spraying GA3 at 300ppm	10.93	10.46	0.294	0.307	37.18	34.07	103.28	109.59	0.53	0.56
Bagging	9.42	9.50	0.305	0.322	30.89	29.50	102.23	106.50	0.48	0.51
Pollination with Malizi guava	10.18	10.21	0.382	0.426	26.65	23.97	162.25	167.39	0.44	0.47
Pollination with Gizi guava	10.22	10.31	0.353	0.372	28.95	27.72	119.41	125.54	0.69	0.73
Branch bending	9.94	9.87	0.286	0.301	39.93	37.81	102.12	108.38	0.73	0.81
L.S.D. at 5% level	**1.37**	**1.22**	**0.032**	**0.035**	**3.37**	**4.13**	**21.15**	**23.41**	**0.05**	**0.07**

From the above mentioned results, it could be concluded that planting Banati guava trees with Malizi guava trees to encouragement the cross-pollination, in addition to spraying GA3 at 400 ppm followed by spraying 500 ppm GA3 one time at the full bloom seems to be a promising treatment not only to overcome the low yield problem of Banati guava trees grown under sandy soil condition but also for improving fruit quality.

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تأثير استخدام الجبريللين والتلقيح اليدوى و ثنى الأفرع على انتاجية و جودة ثمار الجوافة البناتى المنزرعة فى الأراضى الرملية

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أجريت هذة الدراسة خلال موسمين متتاليين ٢٠١٠ و ٢٠١١ على أشجار جوافة بناتى والمنزرعة فى أرض رملية بمنطقة جنوب التحرير بمحطة بحوث على مبارك حيث تم رش الجبريللين بمعدلات ٣٠٠ و ٤٠٠ و ٥٠٠ جزء فى المليون مرة واحدة فى وقت التزهير الكامل للأشجار كما تم عمل التلقيح اليدوى للأشجار بحبوب لقاح من الجوافة بالإضافة إلى الماليزى والجوافة الجيزى كما تم عمل ثنى للأفرع.

وأوضحت النتائج أن معظم المعاملات خاصة تلك التى تم رش الجبريللين بها بتركيز ٤٠٠ جزء فى المليون كان أكثر كفاءة فى حالة عدد ثمار العقد / متر وكذلك نسبة العقد وبالتالى تحسن المحصول والصفات الطبيعية للثمار. وأدى التلقيح اليدوى للجوافة البناتى بحبوب لقاح من أزهار الجوافة الماليزى الى زيادة معنوية فى الحموضة الكلية وفيتامين(ج) كما أدى ثنى الأفرع لاعطاء نسبة عالية من السكريات الكلية . لذلك فان رش أشجار الجوافة البناتى بالجبريللين بتركيز ٤٠٠ جزء فى المليون مرة واحدة عند التزهير الكامل يبدو أنها هى المعاملة الأفضل فى زيادة انتاجية أشجار الجوافة البناتى المنخفضة المحصول والنامية تحت ظروف الأراضى الرملية.

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