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Effect of Summer Pruning and GA_3 Spraying on Inducing Flowering and Fruiting of Zebda Mango Trees

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Abstract: This study was carried out to evaluate the effect of summer pruning and GA_3 spraying after fruit setting in the on year on inducing flowering and yield in the off year season of mango cv Zebda. Trees were subjected to the following pruning treatments, light, moderate and severe pruning. Pruning treatments were done after fruit setting during the last week of May in 2005 and 2006 seasons. Trees were sprayed immediately after pruning with GA_3 at 0, 25, 50 or 100 ppm. The highest number of new flushes per shoot was achieved with severe pruning and spraying GA_3 at 100 ppm. Moderate pruning with GA_3 at 100 ppm was the most effective treatment for increasing length of new flushes and recorded the highest number of leaves per flush. Severe pruning and application of GA_3 at 50 ppm gave the maximum number of panicles per shoot. The longest panicle resulted from moderate pruning and GA_3 at 100 ppm. Severe pruning treatment with either GA_3 concentrations was the most effective for increasing number of fruits per tree. The highest fruit weight was recorded with moderate pruning without spraying GA_3. Moderate pruning and GA_3 at 50 ppm proved to be the most effective treatment for improving yield of Zebda mango trees in the off- year season.

Key words: Mango (*Mangifera indica,* L.) · Pruning · GA_3 · Fruit yield

INTRODUCTION

Mango (*Mangifera indica,* L.) one of the most important fruit crops in Egypt. Irregular bearing is a serious problem affecting mango production where, mango cv Zebda is suffering from this phenomenon. In the on years, trees of this cultivar bear too much fruits with poor vegetative growth. Limited number of new shoots will develop during the flowering and fruit growth period. Encourage vegetative growth as possible during the period of fruit growth in the on year season is very important for increasing yield in the next year. Pruning branches which produced panicles but failed to retain fruit and failed to produce new shoots in the on year can be used to induce new flushes which will bear fruits in the off year.

Also GA_3 spraying after setting in the on year seasons may help to produce new flushes in the summer which will bear panicles in the off year. Pruning is one of the oldest horticultural practices adopted in temperate fruit crops, but it is rarely practiced in evergreen tropical fruits like mango. However, some studies indicate favorable influence of pruning on mango in relation to better fruit set and yield in pruned trees[1,2]. Fivaz *et al.* [3] indicated that fruit size of Tommy Atkins and Sensation mango cultivars was increased by using pruning after fruit set. Also Shinde *et al.* [4] and Crane [5] stimulated fruit production of mango, lime and guava by using pruning. Shaban [6] induced flowering and yield of Hindi Bisinnara mango trees by pruning. Moderate pruning by removal about 20 cm shoot apex from top after harvesting fruit in July would be an available option for sustained production for the high density Amrapali mango orchard [2]. Melouk [7] stimulated vegetative growth of Succary abiad mango cv by pruning. Salem *et al.* [8] showed the vegetative growth of Baldy mandarin trees was improved by pruning. Many investigators used GA_3 for improving yield of different mango cultivars, Rajput and Singh [9] found that vegetative growth, length of panicle, fruit set and fruit retention of mango cv Dashehari were increased by application of GA_3 at 15 or 30 ppm. Also, Oosthuyse [10] indicated that the yield and economic returns of mango cv Tommy Atkins were improved by application of GA_3 during flowering or just before fruit drop. Shinde *et al.* [11] controlled recurring flowering in Alphonso mango by GA_3 at 50 to 100 ppm. Moreover, Katsuaki and Naoki [12] indicated that the fruit weight and yield of Irwin mango

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cultivar were improved by application of GA_3 at the end of the physiological fruit drop stage. Similarly, Sarkar and Ghosh [13] and Ruby and Brahmachari [14] showed that the fruit weight and yield of mango cv Amrapali were increased with application of GA_3 at pea or marble stage of fruit growth. Benjawan *et al.* [15] concluded that GA_3 is needed for high fruit production whenever mango trees started to produce flowers. Also, Birendra *et al.* [16] found that the fruit set and retention of mango cv Amrapali were enhanced by the application of 100 ppm GA_3.

This study aimed to investigate the influence of summer pruning and GA_3 spraying in the on year on vegetative growth of Zebda mango trees, as well as follow up the effect of summer pruning and GA_3 spraying on flowering and yield in the off year.

MATERIALS AND METHODS

This experiment was conducted during two successive seasons of 2005/2006 and 2006/2007 on Zebda mango trees grown in a private orchard in Giza Governorate. Trees were about 12 years old, grafted on seedling rootstocks, planted on sandy soil at 6x6 meters apart and received the recommended management of the orchard. The selected trees were in the on year and uniform in vigor growth. Trees were subjected to the following pruning treatments, light pruning (removal of 5 cm shoot apex from top of terminal flushes), moderate pruning (removal of 10 cm shoot apex from top) and severe pruning (removal of 30 cm shoot apex from top) beside the control trees which were left without pruning. Pruning treatments were done after fruit setting during the last week of May in 2005 and 2006 seasons. Trees were sprayed immediately after pruning with GA_3 at 0, 25, 50 or 100 ppm, while the control trees were sprayed with tap water only. The experiment consisted of 16 treatments and three trees were selected as replicates for each treatment. The complete randomized block design was arranged with one tree for each replicate. The experiment was repeated on another group of trees in the second season. On each tree, 30 terminal shoots were tagged to determine number of new developed vegetative flushes per shoot, length (cm) of new developed flushes per shoot and number of leaves on the new flushes. These observations on vegetative growth were recorded during the end of the on year (last week of October in 2005 and 2006 seasons). Also the same tagged shoots were used to follow up the impact of the different treatments on number of panicles per shoot and panicle length (cm) in the off year 2006 and 2007 seasons. At harvest (last week of August) nine fruits were taken randomly from each replicate for determination of fruit weight (g) and yield (number of fruits per tree).Tree yield (kg) was also calculated by multiplying number of fruits per tree x average fruit weight at harvest. These parameters were estimated in the off year. Data were tabulated and statistically analyzed according to Snedecor and Cochran [17] and the mean values were compared by Duncans multiple range test at 5% [18].

RESULTS AND DISCUSSION

Number of New Developed Flushes per Shoot: Data presented in Table 1 indicated that pruning significantly increased number of new developed flushes per shoot over the control. Severe pruning recorded the highest number followed by moderate and light pruning. This trend was noticed in both seasons of the study. Application of GA_3 increased the number of new developed flushes per shoot compared to the control, while the highest significant effect was recorded with GA_3 at 100 ppm followed by GA_3 at 50 ppm. Also, application GA_3 at 25 ppm increased number of new developed flushes per shoot, but the differences were insignificant in both seasons. Concerning the interaction between pruning and GA_3 treatments, the highest number of new developed flushes per shoot was achieved with severe pruning and spraying GA_3 at 100 ppm than GA_3 at 50 ppm in both seasons.

These results are in harmony with those obtained by Kulkarni [19] who reported that pruning of Alphonso mango trees in February resulted in immediate production of vegetative growth. Moreover, Nunez-Elisea *et al.* [20] reported that removing apical buds of mango by pruning stimulated initiation of shoots from axillary buds.

Melouk [7] stimulated vegetative growth of Succary abiad mango cv by pruning. Besides, Rajput and Singh [9] found that spraying Urea and GA_3, singly and in combination, increased vegetative growth of mango cv Dashehari.

Length of New Developed Flushes per Shoot: Data in Table 2 indicated that a significant increase in length of new developed flushes with all pruning treatments compared to the control. The highest value of new flushes length was recorded with moderate pruning followed by light pruning then severe pruning and the differences were significant compared to the control. The reduction in length of new flushes under severe pruning may be due to the effect of severe pruning on inducing new flushes.

Table 1: Effect of summer pruning severity and GA_3 spraying on number of new developed flushes per shoot of Zebda mango cultivar in 2005 and 2006 seasons

	2005 season					2006 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	0.4i	0.8h	1.3g	1.8f	1.07C	0.7j	0.96i	1.00i	1.40h	1.01C
Light	1.8 f	1.8f	1.9f	2.0ef	1.87B	1.9fg	1.80g	1.80g	2.00efg	1.88B
Moderate	2.0ef	2.2de	2.4cd	2.6c	2.30B	2.1ef	2.20de	2.40cd	2.50c	2.30B
Severe	2.2de	2.2de	3.3b	3.8a	2.87A	2.3cde	2.40cd	3.00b	4.10a	2.95A
Mean	1.60B	1.75B	2.22A	2.55A		1.75B	1.84B	2.05AB	2.50A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

Table 2: Effect of summer pruning severity and GA_3 spraying on length (cm) of new developed flushes of Zebda mango cultivar in 2005 and 2006 seasons

	2005 season					2006 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	13.5 m	15.3 l	21.9 h	23.1 f	18.45 D	12.1 p	13.2 n	12.4 o	19.9 j	14.40 C
Light	17.7 k	17.8 k	22.6 g	34.1 b	23.05 B	21.2 h	18.8 l	22.1 g	28.1 d	22.55 B
Moderate	19.4 i	31.1 e	32.8 c	38.6 a	30.48 A	19.2 k	26.9 e	32.2 b	38 a	29.08 A
Severe	13.4 m	18.8 j	22.6 g	31.6 d	21.60 C	15.6 m	20.3 i	22.6 f	31.4 c	22.48 B
Mean	16 D	20.75 C	24.98 B	31.06 A		17.02 D	19.80 C	22.33 B	29.35 A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

A direct relationship was found between length of new flushes and GA_3 concentrations as the highest length value was recorded with GA_3 at 100 ppm followed by GA_3 at 50 or 25 ppm. On the other hand, the shortest new flush was found on trees that did not receive any GA_3 treatments. The interaction between pruning severity and GA_3 concentrations revealed that moderate pruning with GA_3 spray at 100 ppm was the most effective treatment for increasing length of new flushes. In the contrary, the shortest new flush was recorded with the control. In general, for increasing the length of the new flushes for Zebda mango trees, they should receive moderate pruning with spraying GA_3 at 100 ppm. These results are in accordance with those mentioned by Lal *et al.* [1] who found that pruning influenced growth of Dashehari mango trees and increased length of emerging shoots on pruned branches. Also, Salem *et al.* [8] showed that the vegetative growth of Baldy mandarin trees was improved by pruning.

Number of Leaves per Flush: Number of leaves per flush was significantly influenced by pruning treatments (Table 3). The highest number of leaves per flush was produced in moderate pruning followed by light pruning and the differences were significant in both seasons. Also, severe pruning increased number of leaves per flush significantly compared to the control which produced the lowest number of leaves per flush. Concerning the effect of GA_3 on number of leaves per flush, it was noticed that all GA_3 concentrations increased number of leaves per flush significantly compared to the control. Moderate pruning with application of GA_3 at 100 ppm recorded the highest number of leaves per flush followed by light pruning with GA_3 at 100 ppm. Also moderate pruning with GA_3 at 50 or 25 ppm was more effective in increasing number of leaves per flush compared to the control. These results are in harmony with those obtained by Oosthuyse and Jacobs [21] who demonstrated that, tipping can be used to eliminate the problems associated with poor branching, where it increased number of terminal shoots and number of canopy leaves of Sensation and Kent mango trees.

Number of Panicles per Shoot: Pruning treatments induced the number of panicles per shoot (Table 4). Increasing pruning severity caused a significant increase

Table 3: Effect of summer pruning severity and GA_3 spraying on number of leaves per flush of Zebda mango cultivar in 2005 and 2006 seasons

	2005 season					2006 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	7.5 m	9.5 k	14.6 f	14.8 f	11.60 C	10.3 i	8.0 k	9.8 j	14.3 e	10.60 C
Light	7.4 m	12.6 h	11.5 i	20.6 b	13.02 B	10.5 i	10.8 h	11.6 g	18.4 b	12.82 B
Moderate	10.5 j	18.5 d	20.2 c	27.6 a	19.20 A	11.0 h	14.3 e	16.8 d	20.7 a	15.70 A
Severe	8.5 l	9.3 k	14.2 g	17.2 e	12.30 BC	9.8 j	11.4 g	13.8 f	17.8 c	13.20 B
Mean	8.47 D	12.48 C	15.13 B	20.05 A		10.40 D	11.13 C	13.00 B	17.80 A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

Table 4: Effect of summer pruning severity and GA_3 spraying on number of panicles per shoot of Zebda mango cultivar in 2006 and 2007 seasons

	2006 season					2007 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	0.6 h	1.4 e	1.5 de	1.0 f	1.12 C	0.8 i	1.0 h	1.3 g	1.0 h	1.02 C
Light	0.8 g	1.8 c	1.8 c	1.6 d	1.50 C	1.4 g	1.4 g	1.8 f	1.7 f	1.57 B
Moderate	2.0 c	2.0 c	2.0 c	2.0 c	2.00 B	2.0 e	2.1 de	2.6 b	2.0 e	2.17 A
Severe	2.4 b	2.2 b	3.0 a	2.4 b	2.50 A	2.2 cd	2.3 c	3.0 a	2.2 cd	2.42 A
Mean	1.45 B	1.87 A	2.07 A	1.75 AB		1.60 B	1.70 B	2.17 A	1.72 B	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

Table 5: Effect of summer pruning severity and GA_3 spraying on panicle length (cm) of Zebda mango cultivar in 2007 and 2008 seasons

	2006 season					2007 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	8.0 i	9.3 h	10.0 g	11.0 ef	9.57 C	9.4 i	11.0 g	10.3 h	11.9 e	10.65 D
Light	11.7 cd	10.0 g	11.5 cde	12.0 c	11.30 B	11.0 g	12.7 c	13.0 b	12.6 c	12.32 B
Moderate	14.0 ab	14.2 a	13.5 b	13.8 ab	13.88 A	13.6 a	13.5 a	13.2 b	13.6 a	13.48 A
Severe	11.0 ef	12.0 c	11.2 def	10.9 f	11.27 B	12.2 d	11.0 g	11.5 f	10.9 g	11.40 C
Mean	11.18 A	11.38 A	11.55 A	11.93 A		11.55 B	12.05 AB	12.00 AB	12.25 A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

in number of panicles per shoot, the highest number was recorded with severe pruning followed by moderate and light ones. Meanwhile, control trees produced the lowest number in this respect. Number of panicles per shoot was significantly increased with application of GA_3 at 50 or 25 ppm compared to the control. Also, GA_3 at 100 ppm increased number of panicles per shoot, although the differences were insignificant when compared to the control in the first season.

In the second season, it was noticed that GA_3 at 50 ppm proved to be the most important treatment for increasing the number of panicles per shoot followed by 100 ppm and 25 ppm. Meanwhile, the lowest number was recorded with the control.

Interaction between pruning severity and GA_3 concentrations indicated that severe pruning and application of GA_3 at 50 ppm gave the maximum number of panicles per shoot, meanwhile the minimum number was recorded with the control. This increase in number of panicle per shoot with severe pruning may be due to inducing new vegetative flushes after pruning which will bear the panicles in the next year. These results are in accordance with the finding of Mohan *et al.* [22],

they demonstrated that pruning of Dashehari mango trees in New Delhi during July, August and December doubled number of panicles per pruned shoot. Moreover, Ingle *et al.* [23] stated that, medium pruning recorded the highest value for the number of flowers per shoot of acid lime trees. Similarly, Yeshitela *et al.* [24] used pruning for flowering synchronization of Keit and Tommy Atkins mango trees.

Panicle Length (cm): Data in Table 5 revealed that significant differences in panicle length between the three tested pruning treatments and the control. The longest panicle resulted from moderate pruning followed by light pruning and the differences between them were significant in both seasons. On the other hand, the shortest panicles were obtained by the control. GA_3 treatments did not show significant effect on panicle length, except the concentration of 100 ppm in the second season which increased panicle length significantly comparing with the control. Interaction between pruning and GA_3 revealed that pruning was more effective in increasing panicle length than GA_3 as the panicle length differed significantly among the three levels of pruning. Meanwhile, the differences between all GA_3 concentrations inside the same level of pruning were insignificant. In this concern, Mohan *et al* [22] reported that pruning reduced panicle length of Dashehari mango trees under Indian conditions.

Number of Fruits per Tree: The number of fruits per tree was significantly influenced by pruning severity (Table 6). The highest number of fruits appeared in severely pruned trees followed by moderate and light pruning. Meanwhile, the lowest number was recorded with the control trees. The differences between the three levels of pruning and the control were significant. Increasing number of fruits per tree by pruning may be due to inducing number of vegetative flushes and number of panicles per shoot. Concerning the effect of GA_3 on number of fruits per tree, it could be noticed that, all GA_3 treatments significantly increased this number of fruits per tree than the control. The increase in number of fruits per tree was corresponding with increasing GA_3 concentration since the highest number was obtained by GA_3 at 100 ppm in both seasons. Also GA_3 at 50 or 25 ppm recorded higher number of fruits per tree than GA_3 at zero concentration.

Concerning the interaction between pruning severity and GA_3 concentration, it was noticed that severe pruning with GA_3 at 100 ppm were more effective for increasing number of fruits per tree than 50 or 25 ppm treatments. Consequently, both severe pruning and GA_3 at 100 ppm can be use to increase number of fruits per tree. These results are in line with the findings of Gil *et al.* [25] who pointed that the flowering and fruit set of Haden mango trees were increased by pruning. Also, fruit retention of Sardar guava increased with increasing pruning intensity [26]. Moreover, Shinde *et al.* [4] found that pruning

Table 6: Effect of summer pruning severity and GA_3 spraying on number of fruits per tree of Zebda mango cultivar in 2006 and 2007 seasons

	2006 season					2007 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	16 k	28 j	32 i	34 i	27.50 D	24 i	31 h	37 g	43 f	33.75 D
Light	27 j	40 h	44 g	45 fg	39.00 C	33 h	44 f	47 e	54 d	44.50 C
Moderate	47 f	55 d	62 c	67 ab	57.75 B	48 e	56 d	61 c	64 b	57.25 B
Severe	51 e	65 b	67 ab	69 a	63.00 A	54 d	68 a	68 a	70 a	65.00 A
Mean	35.25 C	47.00 B	51.25A	53.75 A		39.75 C	49.75 B	53.25AB	57.75 A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

Table 7: Effect of summer pruning severity and GA_3 spraying on Fruit weight (g) of Zebda mango cultivar in 2006 and 2007 seasons

	2006 season					2007 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	437.0 e	436.0 e	409.8 gh	404.3 h	421.77 C	455.2 fg	445.3 g	418.6 hi	412.9 i	433.00 B
Light	461.6 d	459.2 d	420.3 f	415.4 fg	439.12 B	472.7 de	461.2 ef	449.0 fg	422.3 hi	451.30 B
Moderate	500.7 a	496.8 a	476.4 b	471.0 bc	486.22 A	512.4 a	492.3 b	485.8 bc	476.2 cd	491.67 A
Severe	463.5 cd	437.2 e	431.2 e	421.4 f	438.32 B	461.2 ef	430.0 h	425.2 hi	414.3 i	432.67 B
Mean	465.7 A	457.3 A	434.4 B	428.0 B		475.37 A	457.20AB	444.65BC	431.42 C	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

Table 8: Effect of summer pruning severity and GA_3 spraying on tree yield (Kg) of Zebda mango cultivar in 2006 and 2007 seasons

	2006 season					2007 season				
	GA_3 concentration (ppm)					GA_3 concentration (ppm)				
SummerPruning Severity	0	25	50	100	Mean	0	25	50	100	Mean
Control	6.96 i	12.20 h	13.99 fg	14.50 f	11.89 C	10.90 h	13.80 g	15.40 g	17.70 f	14.45 C
Light	12.40 gh	18.30 e	18.49 e	18.60 e	16.92 B	15.50 g	20.20 e	21.10 de	22.80 cd	19.90 B
Moderate	23.30 d	27.30 c	29.50 b	31.50 a	27.90 A	24.50 c	27.50 b	29.60 ab	30.40 a	28.00 A
Severe	23.60 d	28.40 bc	28.80 bc	29.07 b	27.45 A	24.90 c	29.20 ab	28.90 ab	29.00 ab	28.00 A
Mean	16.57 B	21.55 A	22.65 A	23.40 A		18.95 B	22.67AB	23.75 A	24.98 A	

Values followed by the same letter (s) in each column are not statistically differed at 5% level

recorded the highest fruits number per tree of mango cv Alphonso. Birendra *et al* [16] reported that the fruit set and retention of mango cv Amrapali were enhanced by the application of 100 ppm GA_3.

Fruit Weight (g): Results in Table 7 showed that moderate pruning significantly increased fruit weight in both seasons comparing with the control. Also, light pruning increased fruit weight than the control and the differences were significant in the first season only. Meanwhile, severe pruning gave slight effect on fruit weight; this may be due to increasing number of fruits per tree under severe pruning and consequently gave a negative effect on fruit weight. Fruit weight was decreased gradually with increasing GA_3 concentration. The highest fruit weight was obtained from unsprayed trees followed by GA_3 at 25 or 50 ppm. Meanwhile, GA_3 at 100 ppm decreased fruit weight significantly. Increasing fruit weight for tress that did not spray with GA_3 may be related to the reduction in number of fruits per tree as shown in Table 6. The interaction between pruning severity and GA_3 cleared that, fruit weight was higher with moderate pruning and GA_3 zero followed by GA_3 25 or 50 ppm. On the other hand, the lowest fruit weight was detected with spraying GA_3 at 100 ppm without pruning. It could be achieved from the above results that moderate pruning can be use for improving fruit weight of Zebda mango cultivar. These results are in harmony with those reported by Fivaz *et al.* [3], who found that pruning after both fruit set and harvest increased fruit size of Tommy Atkins and Sensation mango cultivars. Moreover, Ingle *et al.* [27] indicated that, the highest fruit weight of acid lime was recorded with the application of medium pruning.

Tree Yield (kg): As evident from Table 8, the tree yield was increased significantly with the severity of pruning. The highest yield was recorded under sever or moderate pruning and the differences between them were insignificant. Also, light pruning increased yield than the control, however, its effect came next to severe and moderate pruning in this respect. This increase in tree yield by pruning may be due to inducing number of panicles per shoot and subsequently increasing number of fruits per tree. Concerning the effect of GA_3 on tree yield, it was noticed that, all GA_3 concentrations significantly increased tree yield compared to the control, this was true in both seasons, except GA_3 at 25 ppm in the second season which recorded insignificant differences with the control. Interaction between both pruning severity and GA_3 concentrations cleared that, moderate pruning treatment and GA_3 at 100 ppm or 50 ppm proved to be more effective in this respect. On the other hand, the lowest yield was recorded with the control. These results are in harmony with those reported by Mohan *et al.* [22], they stated that the fruit yield of Dashehari mango trees was increased by pruning. Similarly, Shinde *et al.* [28] indicated that the fruiting and yield in mango cv Alphonso were induced by pruning. Moreover, Crane [5] showed that the fruit production of mango, lime and guava was stimulated by using pruning. Sarkar and Ghosh [13] and Ruby and Brahmachari [14] mentioned that the fruit weight and yield of mango cv Amrapali were increased with application of GA3. Ingle *et al.* [27] concluded that, acid lime trees produced the highest significant yield with the application of medium pruning (removal of terminal shoots up to 45 cm).

CONCLUSION

It could be concluded that the promising pruning treatment is moderate pruning and spraying with GA_3 at 50 ppm, since it increased length of new flushes, panicle length and improved yield of Zebda mango trees in the off- year season.

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