Effect of pruning, defoliation and nitrogen fertilization on growth, fruit set and quality of Abdel-Razik Annona cultivar

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The investigation was carried out during two successive seasons of 2008 and 2009 on Abdel-Razik cultivar Annona. The trees were 8 years old grown in a private orchard at El-Sadat district, Menofiya Governorate. The study aimed to show the effect of some pruning levels, defoliation and nitrogen fertilization on growth, fruit set and quality. Results revealed that, N fertilization combined with pruning regimes gave the greatest values. Such treatments led to increase the lateral shoots number of leaves per shoot. The effective treatment was heading back by removing 20cm from shoot top plus N fertilization. All pruning treatments including defoliation either with or without N fertilization advanced flowering date while flowering period was not affected. The investigation showed that pruning regimes and pruning combined with N fertilization treatment increased number of flower per shoot, fruit set percentage and yield. The effective treatment, in this respect, was heading back by removing 10cm of shoot top +N fertilization. Such treatment had the highest value of fruit weight. No significant differences between different treatments and control concerning the fruit height, diameter and H/D, ratios were found. Treatments with N fertilization decreased the presence of TSS while total acidity was increased, this led to decrease in TSS/acid ratio, Nitrogen fertilization increased leaf content of N and P while leaf content of K was not affected. Results revealed that, N fertilization supported with pruning improved growth, fruit set and fruit quality.
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Key words: Annona, Pruning, defoliation, N fertilization, fruit set. Fruit quality, thinning.
Abbreviations: HB = Heading back, LS = Lateral shoots, Def= Defoliation, TO = thinning out.

Introduction

In Annona atemoya, there were positive linear relations of tree yield to tree girth, but was not with cross-sectional area, canopy volumes and number of laterals, while fruit weight was negatively related to fruit number per tree. On almb basis, mean fruit size and pulp: seed ratio was weakly related to the leaf area per fruit (George and Nissen, 1986b).

Defoliation of *Annona muricata* either manually or chemically increased the number of flowers and annual fruit production (CruZ and Cedeno, 1989). Different pruning techniques used in cherimoya cultivation for increasing production. Several of these techniques allow trees to be kept permanently under 3 meter in height. Cherimoya trees seemed to remain productive at a reduced size, producing yield similar to those of conventional large trees but with bigger fruit (Farre et al., 2000). Shoot tipping in cherimoya at 10 buds and its combination with bark girdling obtained the best results, with an increase of 22% in yield and 25% in fruit weight, respectively. Shoot tipping also significantly decreased shoot length according to the date it was done (Bruno and Evelyn 2001).

Pruning is necessary for cherimoya (*Annona. Cherimoya*) trees and it must be done after leaf defoliation. Fertilization with ammonium nitrate or sulphate after pruning increased number of flowers and yield. Nitrogen fertilization overcomes the negative effect of pruning in Annona trees (Kohn et al., 2001). In coffee trees, the advantages of pruning (mainly to improve light distribution and ventilation within the crown and to encourage new growth) are briefly outlined.

Selective pruning consisting of the removal of all broken and diseased branches, gave significantly higher anuol yields (Figueroa, 1991).

Heading back treatment in fig trees led to significant increment in the number of buds developing to vegetative growth, length of new shoot and average number of leaves arised on those shoots in relation to thinning treatment. TSS and juice acidity were not significantly affected by pruning regime (Stino and El-Fakharani 1995).

Heading back weakens apical dominance lead to the release of many buds from dormancy and the

development of vigorous shoots in apple and pear trees (Forshey et al., 1992).

The best growth of Annona to the normal trees was obtained with high N application rate. Flowering was advanced by 10-15 days while low nitrogen levels and fruit set percentage was enhanced (Sadnh and Ghosh, 1976). Nitrogen fertilization significantly increased total number of flowers, percentage of fruits set, total yield and acidity while TSS was decreased in Annona fruits (Said A. Galila and El-Massry, 1991). Shoot growth rate and number of leaves were highest in sugar apple (Annona squamosa. L.) when high levels of N, P, K were applied the flowering was earliest. Production of greatest number of flowers, higher fruit set, fruit retention and yield were also obtained with the highest N.P.K. rate (Ashutosh et al. 1995).

Nitrogen fertilization was most beneficial in custard apple (Annona squamosa) and necessary for good production and vegetative growth (Zang and Xu, 2002).

Materials and Methods

This investigation was carried out on 10-year-old Annna trees Abdel-Razik cv. Grown in a private orchard at El-Sadat district, Menofiya Governorate during two consecutive seasons i.e. 2008 and 2009.

The trees planted in sand soil, irrigated with drip system and subjected to the normal horticultural practices.

For this study thirty-six uniform trees were chosen. Hand defoliation was conducted on the chosen trees except control and trees received nitrogen fertilization without pruning regimes on mid. January in each studied season. Then, ammonium nitrate (33.5%) was added twice in (1^{st} Feb and 1^{st} Apr.) at rate of 100kg./fedd divided to daily applications (Fertigation) at each date during both studied seasons.

Twelve completely randomized treatments each of three replicates were conducted as follows:

1- Control (untreated) trees.
2- Nitrogen fertilization only.
3- Defoliation + nitrogen fertilization.
4- Heading back by removing 5cm from shoot top + nitrogen fertilization.
5- Heading back by removing 10cm from shoot top + nitrogen fertilization.
6- Heading back by removing 20cm from shoot top + nitrogen fertilization.
7- Thinning out (removing 1/3 numbers of shoot /tree) + nitrogen fertilization
8- Defoliation.
9- Heading back by removing 5cm from shoot top.
10- Removing 10cm from shoot top.
11- Heading back by removing 20cm from shoot top.

The following measurements were taken:

1- Number of lateral shoots and leaves number per shoot.
2- Average number of flowers, then fruit set percentage was estimated and yield components (number of fruits/ tree and Kg/tree).
3- Some physical properties of fruit i.e. fruit weight, fruit height, fruit diameter and H/D ratio.
4- Some chemical properties of fruit i.e. total soluble solids percentage (TSS%) using rafractometer, total acidity (g/100g) using titration NaOH at O/N and phenolphethalene as an indicator and expressed as citric acid along with TSS/acid., ratio.

Chosen trees under study were left to open pollination. The complete randomized design was followed throughout the whole study. The data was subjected to analysis of variance (ANOVA). The new L.S.D test was used for comprising the means (Snedecor and Cochran 1977).

Results and Discussion

Data in table (1) show the effect of some pruning levels and nitrogen fertilization on number of laterals shoot and number of leaves per shoot. Generally, no new laterals emerged on shoots of control trees. Mean while, pruning regimes enhanced growth of lateral shoots and leaves number per shoot.

Defoliation and removing 5cm. from shoot top regimes gave 1.3 & 1.0 and 1.3 & 1.3 lateral shoot (LS) with average leaves number of 42.6 & 47.8 and 47.9 & 48.0 leaves/shoot. The highest values concerning average number of lateral shoot 4.5 and 4.8 and number of leaves/shoot 53.0 and 52.6 were obtained from heading back by removing 20cm from shoot top treatment while removing 10cm and thinning out treatments gave intermediate values 3.4 & 2.4 & 2.0 & 1.3 lateral shoots, respectively. Such treatment had

51.5 & 50.4 and 48.3 & 48.0 leaves/shoot in the first and second seasons, respectively.

Nitrogen fertilization had additive effect in this respect. Such treatment gave 1.0 and 1.0 lateral shoot and 48.6 and 47.7 leaves per shoot, in addition, N fertilization combined with pruning regimes significantly increased average number of lateral /shoot and leaves per shoot compared to control. The most effective treatment was heading back by removing 20cm. plus nitrogen fertilization which produced 73 and 5.2 lateral shoots (Ls) and highest number of leaves per shoot 60.3 and 59.2 followed by removing 10cm plus N fertilization had 5.1 and 5.0 lateral shoots with 56.0 and 54.9 leaves/shoot.

Defoliation and HB by removing 5cm.plus N fertilization treatment arranged between the above mention values, this is clear in both studied seasons, respectively.

These results were in agreement with the finding of Kahn et al. 2001 on Annona cherimoya who revealed that, N-fertilization after leaf defoliation and pruning increased number of lateral shoots. Moreover, Zzng and XV (2002) on Annona squamosa (sugar apple) found that, N fertilization after pruning practice was necessary for good production and growth. Also, Cruz and Cedeno (1989) noticed that, defoliation handily or chemically in Annona gave significantly greater number of lateral shoots as compared to the control.

Moreover, Forshey et al., (1992) stated that, heading back weakens apical dominance and this lead to the release of many buds from dormancy and the development of vigorous shoots in apple and pear trees. In addition, Stiuo and El-Fakharani (1995) mentioned that, the heading back treatment in fig tree led to significant increment in the number of buds developing to vegetative growth and average number of leaves arise on shoots in relation to thinning treatments.

2- Number of flowers per shoot, fruit set and yield:

As shown in table (2), number of flowers increased in all treated trees compared to untreated ones. In this respect, all pruning level treatments including defoliation plus N fertilization gave the best results in increasing number of flower per shoot from 39.3 to 51.1 and from 40.1 to 52.7 in the first and second seasons, respectively. While pruning without nitrogen fertilization gave 36.0 to 43.5 and from 35.6 to 44.0 flowers. In addition, nitrogen fertilization treatment increased values of average number of flower buds per shoot (38.2) and (37.5) as compared to control tress (33.4 and 34.8) flowers in the first and second season respectively. Data reveled that, HB by removing 10 cm. from shoot top plus nitrogen fertilization gave the best effect concerning average number of flowers emerged on shoot (51.1 and 52.7) in both studied seasons, respectively.

Concerning percentage of fruit set and yield per tree, data in table (2) showed that, untreated (control) trees gave only 2.0 % fruit set, resulted in low yield either as number of fruits per tree (8.1 and 7.4) or as weight (2.360 and 2.208 kg/tree) in both studied seasons.

This percentage increased to 5.0 and 4.6 % with nitrogen fertilization treatment which produced 12.5 and 10.5 fruits per tree and weighted 3.776 and 3.195 kg/tree. In addition, pruning regimes including defoliation increased percentage of fruit set from (5.4 to 10.1%) and from (5.1 to 10.0%) with average number of fruits per tree ranged between 13.0 & 27.0 and between 12.7 & 24.5 fruits /tree which weighted from 3.903 to 9.763 and from 3.737 to 8.771 kg/tree. Moreover, when nitrogen fertilization combined with pruning levels, it supported results in this respect, which fruit set increased from 8.3 to 14.6 and from 7.5 to 14.8% produced highest number of fruits per tree ranged between 14.9& 40.1 and between 13.1 & 41.3 with best results of fruit weight ranged between 5.402 to 15.077 and between 4.704 to 15.755 kg/tree in the first and second, respectively.

It is obvious to notice that, treatment of heading back by removing 10cm. plus N-fertilization gave the highest values of fruit set percentage, 14.6 and 14.8% and yield either as number of fruit per tree, 40.1 and 41.3 or as weight, 15.077 and 15.755 kg/tree. It is clear that. Nitrogen fertilization supported pruning for improving fruit set and yield in Adel-Razik Annona cultivar.

The obtained results in agreement with the finding of Kahn et al. (2001) who revealed that, N-fertilization after pruning increased number of lateral shoots and number of flowers per shoot in cherimoya. Also, Figueroa (1991) on coffee and George and Nissen (1985b) on Annona, mentioned that, there were linear relations of tree yield to girth, but cross sectional area, canopy values and number of lateral shoots.

In addition, Croz and Cedeno (1989) noticed that, mannal defoliation gave highest production in *Annona muricater*. Also, Farre et al., (2000) found that, Annona Cherimoya trees seemed to remain productive at reduce size, producing yield similar to those of conventional large trees but with bigger fruits. Moreover, Bruno and Evelyn (2001) mentioned that, shoot tipping in cherimoya increased yield by 22% as compared to control. Concerning the effect of N-fertilization, Said, A. Galial and El-masry (1991); Ashotosh, et al., (1995) and Zang and XU (2002) found

that, N. fertilization increased number of flowers, fruit that, N. fertilization increased number of flowers, fruit set percentage and yield in Annona.

3- Physical Properties of fruit:

The effect of pruning levels a lone and combined with nitrogen fertilization on fruit weight, fruit height, fruit diameter and H/D, ratio were shown in table (3). Data revealed that, N-fertilization increased fruit weight from 291.4 to 302.1g and from 298.5 to 309.3g while pruning practices either as HB by removing 5, 10, 20 cm. and thinning out gave higher values of fruit weight ranged between 316.2 and 368.4 g. and between 312.7 and 360.2g Mean white. Hand defoliation gave only fruit weighted from 300.3 to 301.4g. Application of ammonium nitrate to pruned trees increased fruit weight from 318.1 to 389.2 g and from 307.6 to 388.3 g. which the highest values in this respect were obtained from pruning of HB by removing 20 cm. plus N-fertilization treatment, in the studied seasons.

Concerning fruit weight and diameter and H/D, ratio, the obtained data showed that, insignificant differences were found between different pruning levels treatments with or without N-fertilization and control during the two studied seasons, respectively.

These results coinciding the finding of Georg nissen (1986 a & b) who mentioned that, fruit weight of atemoya negatively related to fruit number per tree. Moreover, Farre (2000) found that, reduced Annona tree size gave bigger fruit. In addition, Bruno and Evelyn (2001) noticed that, shoot tipping in Annona cherimoya increased fruit weight by 25% as compared to control. On litchi, Somali et al. (2001) found that, different tested levels of pruning increased fruit weight. Also, Kahn et al. (2001) revealed that, N-fertilization after defollation increased fruit weight. Sadnh and Ghosh, (1976), Said, A. Galila and El-Masry (1991) Ashotosh et al., (1993) and Zang and XU (2000) mentioned that N-fertilization advancing flowering date, increased fruit set and weight.

4- Chemical properties of fruits:

As for the effect of pruning levels and nitrogen fertilization, Data in table (4) clearly showed that, total soluble solids (TSS) values were significantly higher in fruits of untreated control trees pruning regimes without nitrogen fertilization which ranged between 20.53 to 20.68 and between 20.49 to 20.62 compared to N-fertilized trees with or without pruning regimes which gave lower values ranged between 19.13 to 19.85 and between 1944 to 19.86 in the first and second seasons, respectively.

Acidity values also showed insignificant increments with fruit of pruned and pruned trees received N application which arranged between (0.22) to (0.23) in the first and second season respectively.

Thus TSS/acid, ratio significantly increased in fruit of control and pruning regimes from 93.17 to 94.00 from 93.12 to 93.12 to 93.64 compared to N-fertilized trees which gave lower TSS/acid ratio arranged between 76.52 to 82.38 and between 79.44 to 82.50 in the first and second seasons, respectively.

In addition, said, A. Galila and El-Masry (1991) mentioned that nitrogen fertilization significantly increased acidity while T.S.S. was decreased in Annona. On the other hand, Sonali, et al., (2001) revealed that with 5 levels of pruning in litchi trees, all treatments increased number of fruit per panicle, fruit weight, yield, T.S.S. and total sugars and ascorbic acid content.

5- Leaf content of N, P, K :

Effect of some pruning levels and nitrogen fertilization on leaf content of N, P and K presented in Table (S), the obtained results revealed that, pruned and non pruned trees received nitrogen fertilization gave insignificants of N and P content as compared to control and pruned trees without nitrogen fertilization- Moreover, leaf content of K not affected significantly between all tested treatments and untreated (control) tree in both investigated seasons. In this respect, said, A. Galila and El-Masry (1991) on Annona, found that, nitrogen fertilization resulted in gradual and significant increased in leaf content of N and P, whereas, it failed to exert any considerable effect on leaf K content.

Table (1): Effect of pruning, defoliation and N-fertilization on number of lateral shoots and leaves/shoot on Abdel-Razik Annona cultivar during 2008 and 2009 seasons.

Treatments	First season		Second season	
Control	0.3	47.1	0.0	47.3
N-fertilization	1.0	48.0	1.0	47.7
defoliation+ N-fertilization	1.7	484	1.6	48.0
HB by removing 5cm+N	1.7	48.7	2.0	49.1
HB by removing 10cm+N	5.1	56.0	5.0	54.4
HB by removing 20cm+N	7.3	60.3	5.2	59.2

Thinning out + N	4.1	49.2	3.0	48.0
Defoliation	1.3	42.6	1.0	47.8
HB by removing 5cm	1.3	47.9	1.3	48.0
HB by removing 10cm	3.4	51.5	2.4	50.4
HB by removing 20cm	4.5	53.0	4.8	52.6
Thinning out	2.0	48.3	1.3	48.0
New L.S.D at 0.05	1.36	3.51	1.14	4.01

Table (2): Effect of pruning, defoliation and N-fertilization on number of flowers, fruit set% and yield components on Abdel-Razik Annona cultivar during 2008 and 2009 seasons.

Treatments	First season				Second season			
	No of flowers	Fruit set(%)	Yield components		No of flowers	Fruit set(%)	Yield components	
			No of fruit per tree	Kg/ tree			No of fruit per tree	Kg/ tree
Control	33.4	2.1	8.1	2.360	34.8	7.4	7.4	2.208
N-fertilization	38.2	5.0	12.5	3.716	37.5	10.5	10.5	3.195
defoliation+ N-fertilization	39.3	8.3	19.3	6.139	40.1	16.3	16.3	5.013
HB by removing 5cm+N	40.6	12.2	33.6	10.842	42.4	32.1	32.1	10.605
HB by removing 10cm+N	51.1	14.6	40.1	15.077	52.7	41.3	41.3	15.755
HB by removing 20cm+N	44.2	13.7	36.8	14.322	44.9	34.6	34.6	13.435
Thinning out + N	41.1	7.3	14.9	5.402	43.8	13.1	13.1	4.704
Defoliation	36.0	5.4	13.0	3.903	35.6	12.4	12.4	3.737
HB by removing 5cm	39.7	9.6	20.2	6.387	40.2	228	22.8	7.129
HB by removing 10cm	43.5	10.1	27.0	9.736	44.0	24.5	24.5	8.771
HB by removing 20cm	40.9	9.8	25.7	9.467	41.1	21.8	21.8	7.852
Thinning out	39.4	6.8	13.6	4.761	39.6	12.5	12.5	4.431
New L.S.D at 0.05	2.51	2.81	3.27	2.19	2.41	2.85	2.85	2.06

Table (2): Effect of pruning, defoliation and N-fertilization on some physical properties of fruit on Abdel-Razik Annona cultivar during 2008 and 2009 seasons.

Treatments	First season				Second season			
	Fruit weight	Fruit height cm (H)	Fruit diameter cm (D)	H/D	Fruit weight	Fruit height cm (H)	Fruit diameter cm (D)	H/D
Control	291.4	7.7	7.9	0.90	298.5	7.9	7.9	1.00
N-fertilization	302.1	7.8	7.0	1.00	309.3	7.9	8.0	0.99
defoliation+ N-fertilization	318.1	8.0	8.1	0.99	307.6	8.3	8.4	0.99
HB by removing 5cm+N	322.7	8.1	8.1	1.00	330.4	8.3	8.3	1.00
HB by removing 10cm+N	376.0	8.3	8.3	1.00	381.5	8.5	8.5	1.00
HB by removing 20cm+N	389.2	8.3	8.7	0.95	388.3	8.5	8.6	0.99
Thinning out + N	362.6	8.2	8.3	0.99	359.1	8.3	8.3	1.00
Defoliation	300.3	7.7	7.7	1.00	301.4	7.6	7.6	1.00
HB by removing 5cm	316.2	7.8	7.8	1.00	312.7	8.0	8.0	1.00
HB by removing 10cm	360.6	7.9	8.0	0.99	358.0	8.2	8.3	0.99
HB by removing 20cm	368.4	8.0	8.0	1.00	360.2	8.2	8.2	1.00
Thinning out	350.1	7.8	7.9	0.98	354.5	8.0	8.0	1.00
New L.S.D at 0.05	6.54	N.S	N.S	N.S	6.78	N.S	N.S	N.S

Table (4): Effect of pruning, defoliation and N-fertilization on some chemical properties of fruit on Abdel-Razik Annona cultivar during 2008 and 2009 seasons.

Treatments	First season			Second season		
	TSS	Acidity	TSS/acid ratio	TSS	Acidity	TSS/acid ratio
Control	20.53	0.22	93.31	20.49	0.22	93.13
N-fertilization	19.84	0.25	79.36	19.80	0.24	82.50
defoliation+ N-fertilization	19.77	0.24	82.38	19.68	0.24	82.00
HB by removing 5cm+N	19.71	0.24	82.13	19.70	0.24	82.08
HB by removing 10cm+N	19.13	0.25	76.52	19.44	0.24	81.00
HB by removing 20cm+N	19.85	0.24	82.11	19.86	0.25	79.44
Thinning out + N	19.73	0.24	82.21	19.6	0.24	81.32
Defoliation	20.60	0.22	93.64	20.53	0.22	89.26
HB by removing 5cm	20.64	0.22	93.62	20.60	0.22	93.64
HB by removing 10cm	20.68	0.22	94.00	20.62	0.22	93.12
HB by removing 20cm	20.63	0.22	93.17	20.60	0.22	89.57
Thinning out	20.59	0.22	93.59	20.55	0.22	93.41
New L.S.D at 0.05	0.24	N.S	2.14	0.16	N.S	2.07

Table (5): Effect of pruning, defoliation and N-fertilization on leaf content of N, P, K on Abdel-Razik Annona cultivar during 2008 and 2009 seasons.

Treatments	First season			Second season		
	N	P	K	N	P	K
Control	1.31	0.367	1.07	1.27	0.357	1.10
N-fertilization	1.50	0.398	1.11	1.49	0.369	1.14
defoliation+ N-fertilization	1.56	0.412	1.27	1.53	0.418	1.27
HB by removing 5cm+N	1.61	0.416	1.29	1.57	0.416	1.30
HB by removing 10cm+N	1.59	0.414	1.27	1.57	0.418	1.26
HB by removing 20cm+N	1.59	0.412	1.28	1.54	0.418	1.24
Thinning out + N	1.60	0.412	1.28	1.57	0.416	1.27
Defoliation	1.44	0.374	1.12	1.39	0.366	1.14
HB by removing 5cm	1.48	0.344	1.22	1.40	0.368	1.24
HB by removing 10cm	1.47	0.368	1.27	1.46	0.359	1.26
HB by removing 20cm	1.47	0.374	1.27	1.48	0.354	1.26
Thinning out	1.48	0.368	1.09	1.48	0.351	1.11
New L.S.D at 0.05	N.S	N.S	N.S	N.S	N.S	N.S

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