Effect of Pruning and Nitrogen Fertilization Rates on the Vegetative Growth Characters and Nutritional Status of "Keitt" and "Tommy Atkins" Mango Trees

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Abstract: This investigation was carried out through two successive seasons of 2012-2013 and 2013-2014 in a private orchard at Cairo Alexandria Desert Road, 62 km, Egypt, on 9 years old "Keitt" and "Tommy Atkins" mango trees (*Mangifera indica*. L) budded on white Sukary seedling rootstocks to determine the most appropriate level of pruning and the most suitable rates addition of nitrogen fertilizers and their interactions on vegetative growth aspects and nutritional status of "Keitt" and "Tommy Atkins" mango cultivars. The treatments were divided to three factors (Cultivars "factor a", pruning levels "factor b" which applied after harvest in September by removing 10% or 20% or 30% of the total vegetative growth in addition to control (without pruning) and factor c which was different rates of nitrogen fertilizers application). Nitrogen fertilization rates were divided to the different stages of growth of the plant as follows (50+20+30), (50+30+20), (0+50+30), (50+0+50) in addition to control (recommended fertilization program in the farm). The results showed that the highest number of growth cycle, newly growth length and number of leaves for "Tommy Atkins" mango cultivar, as well as the highest leaf area for "Keitt" mango cultivar were obtained by removing 30% of vegetative growth plus N fertilization at rate (50-0-50) compared to other treatments used in both studied seasons. On the other hand, "Keitt" mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) significantly increased leaf content of nitrogen, phosphorus and potassium compared to other conducted treatments in both seasons of study.

Key words: Keitt · Tommy Atkins · Mango · Pruning · Fertilization · Vegetative growth · Nitrogen · Phosphorus · Potassium

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the important fruits of the tropical and subtropical countries zone of the world. Mango grows on a wide range of climatic and soil conditions in the world [1]. Mango belongs to the family "Anacardiaceae" and is consumed mainly as a fresh fruit or as a juice. Its nutritional value is great and is considered one of the richest sources of vitamins and mineral salts. Besides it contains enough amounts of carbohydrates and proteins. In Egypt, mango is considered as one of the main fruits which rank the third after citrus and grapes. The total acreage of mango in Egypt increased to reach about 289288 feddans producing about 1066404 tons [2]. Growers in Egypt shifted to grow some mango export cultivars such as "Keitt" and "Tommy Atkins". "Keitt" originated in Florida as an open pollinated seedling of Mulgoba cv., growing on the property of Mrs. J.N. "Keitt", Homestead, Florida (U.S.A) in 1939. Meanwhile, "Tommy Atkins" is seedling of the Haden variety and was planted around 1922 in Broward county, Florida (U.S.A) in 1932 [3].

There are many factors that influence yield, maturity and quality of fruits. The same cultivar can attains different characteristics in different growing conditions even in the same region; different environmental conditions at different years can affect maturity and quality of the fruit [4].

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Pruning is an important cultural operation for obtaining quality yield from the fruiting trees, which involves judicious removal of vegetative parts. An unpruned tree becomes very large, which inhibits light penetration inside the canopy. As a result, leaf sprout is decreased, photosynthetic activity remains low and high incidence of pests and disease occurs due to high relative humidity [5].

Fertilization is one of the most important cultural practices carried out during the growing season, especially nitrogen fertilization. Nitrogen is one of the major plant nutrients, being a part of protein, enzymes, amino acids, polypeptides and many other biochemical compounds in plant system i.e. encouraging cell division and the development of meristemiatic tissue [6]. Nitrogen (N) management in maize production system is one of the main concerns since it is the most important and primary nutrient for growth and development of the crop [7].

Therefore, the aim of the present investigation was to determine the most appropriate level of pruning and the most suitable rates for the addition of nitrogen fertilizers and their effect on vegetable growth aspects and leaf mineral of "Keitt" and "Tommy Atkins" mango cultivars.

MATERIALS AND METHODS

This investigation was carried out through two successive seasons of 2012-2013 and 2013-2014 on 9 years old "Keitt" and "Tommy Atkins" mango trees (*Mangifera indica*. L) budded on white Sukary seedling rootstocks. All trees under study were grown on sandy soil in a private orchard at 62 km, Cairo Alexandria Desert Road, Egypt. The trees were similar in growth, vigor and received the normal agriculture practices. In addition, both "Keitt" and "Tommy Atkins" mango trees spaced 2 x 3 meters apart.

The selected trees of both "Keitt" and "Tommy Atkins" mango cultivars were exposed to the following treatments:

Pruning Levels: Three levels of pruning are offered immediately after harvest in September as follows: Removing 10% of the total vegetative growth, removing 20% of the total vegetative growth, removing 30% of the total vegetative growth and control (without pruning).

Nitrogen Fertilizer Application: Nitrogen fertilizer doses were added starting from September until the completion of the growth with rate of 400 g Nitrogen per tree divided on different stages of growth at different rates, these doses are added over a period of one week as shown in Table (A).

The experiment was set in a completely randomized block design with 40treatments each contains of three replicates and each replicate represented by one tree.

Data Recorded
Vegetative Growth: Ten branches of both "Keitt" and "Tommy Atkins" mango cultivars were randomly chosen during September 2012 and 2013 at the four direction of canopy tree and tagged to record the number of growth cycles, newly growth length (cm), diameter of newly formed shoots (cm), leaves number per newly formed shoots and leaf area (cm²) at the end of each season (October 2013 and 2014).

Leaf Mineral Content (%): On the first week of October, in both seasons, 20 mature leaves per replicate were collected from the top of the previously tagged shoots and dried until constant weight then used to determine leaf nitrogen content (%) according to Pregl [8]; leaf phosphorus content (%) according to Jakson [9]; leaf potassium content (%) according to Brown and Lilleland [10].

Statistical Analysis: The obtained data were subject to analysis of variance. The means of values were compared using LSD at 5% levels. The data were tabulated and statistically analyzed according to Complete Randomized Blocks design [11]. As cultivar was factor A, pruning level was factor B and nitrogen fertilizer application plan was factor C. The percentages were transformed to arcsine to find the binomial percentages according to Steel and Torrie [12].

Table A: Shows the nitrogen fertilizer application plan for "Keitt" and "Tommy Atkins" mango cultivars during both seasons of the study

Nitrogen fertilizer Rate	Application stage		
	After harvesting	Beginning of bud differentiation	From the fruit set until fruit maturity
First treatment	50%	20%	30%
Second treatment	50%	30%	20%
Third treatment	0%	50%	50%
Fourth treatment	50%	0%	50%
Fifth treatment	Fertilization program recommended in the farm		

Table 1: Effect of pruning level and N fertilization rate on number of growth cycles of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

Cultivar (A)	Pruning level (B)	Season 2012/2013 (50+20+30)N	(50+30+20)N	(0+50+50)N	(50+0+50)N	Control	Mean (AxB)	Season 2013/2014 (50+20+30)N	(50+30+20)N	(0+50+50)N	(50+0+50)N	Control	Mean (AxB)
Keitt	Removing 10%	1.70	1.70	1.70	1.80	1.63	1.71	1.80	1.70	1.60	1.80	1.70	1.72
	Removing 20%	1.80	1.80	1.70	1.90	1.63	1.77	1.83	1.80	1.77	1.90	1.60	1.78
	Removing 30%	2.10	2.00	1.80	2.27	1.63	1.96	2.10	2.10	1.93	2.20	1.53	1.97
	Control	1.70	1.73	1.70	1.70	1.53	1.67	1.70	1.60	1.77	1.70	1.60	1.67
	Mean (A×C)	1.83	1.81	1.73	1.92	1.61	1.78	1.86	1.80	1.77	1.90	1.61	1.79
Tommy	Removing 10%	1.90	1.90	1.80	2.00	1.67	1.85	2.00	1.90	1.80	2.00	1.80	1.90
	Removing 20%	2.00	2.00	1.80	2.10	1.70	1.92	2.00	1.93	1.90	2.10	1.70	1.93
	Removing 30%	2.20	2.27	1.70	2.37	1.60	2.03	2.23	2.10	1.90	2.33	1.57	2.03
	Control	2.00	1.80	1.67	1.80	1.57	1.77	1.80	1.80	1.80	1.90	1.47	1.75
	Mean (A×C)	2.03	1.99	1.74	2.07	1.63	1.89	2.01	1.93	1.85	2.08	1.63	1.90
Removing 10%		1.80	1.80	1.75	1.90	1.65	1.78	1.90	1.80	1.70	1.90	1.75	1.81
Removing 20%		1.90	1.90	1.75	2.00	1.67	1.84	1.92	1.87	1.83	2.00	1.65	1.85
Removing 30%		2.15	2.13	1.75	2.32	1.62	1.99	2.17	2.10	1.92	2.27	1.55	2.00
Control		1.85	1.77	1.68	1.75	1.55	1.72	1.75	1.70	1.78	1.80	1.53	1.71
Mean (C)		1.93	1.90	1.73	1.99	1.62	---	1.93	1.87	1.81	1.99	1.62	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.05	0.08	0.09	0.11	0.12	0.17	0.24
Season 2013/2014	0.04	0.06	0.07	0.09	0.10	0.14	0.20

RESULTS AND DISCUSSION

Vegetative Growth
Number of Growth Cycles: Date in Table (1) showed the effect of pruning treatments and N fertilization rate on number of growth cycles of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons. Highest significant number of growth cycles was obtained with "Tommy Atkins" mango cultivar as compared to "Keitt" mango cultivar.

With respect to pruning treatments, data clarify that removing 30% of vegetative growth induced significantly the highest values followed by removing 20% and 10% with insignificant between them, while control had the lowest significant values. Regarding N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+20+30) with insignificant between them, whereas control produced significantly the lowest values.

Concerning interaction between type of cultivar and pruning treatments, data showed that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth had significantly the highest values, followed by "Keitt" mango cultivar with removing 30% of vegetative growth with insignificant among them, while "Keitt" mango cultivar with remaining pruning treatments significantly resulted the lowest values.

With respect to interaction between type of cultivar and N fertilization rate, data showed that "Tommy Atkins" mango cultivar with N fertilization rate (50+0+50) had significantly the highest values, followed by N fertilization rate (50+20+30) with insignificant between them, whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control recorded significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data show that removing 30% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed by removing 30% of vegetative growth with N fertilization rate (50+20+30), while control resulted in significantly the lowest values.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+0+50) significantly had the highest values, whereas "Keitt" and "Tommy Atkins" mango cultivars under control treatments either N fertilization or pruning treatments were significantly the lowest values in both seasons of study.

These results are in harmony with those obtained by Rakha [13] who found that Kent mango cv. recorded the highest percentage of growth flushes followed by "Tommy Atkins" mango cv., while "Keitt" mango cv. recorded the lowest percentage. Regarding effect of N fertilization, El-Shenawy [14] reported that KNO_3 treatments either alone or combined with inflorescences thinning stimulated tree growth of mango cv. Keitt.

Length of Newly Growth (Growth Cycles): Date in Table (2) showed the effect of pruning treatments and N fertilization rate on length of newly growth

Table 2: Effect of pruning level and N fertilization rate on newly growth length (cm) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

Cultivar (A)	Pruning level (B)	Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	21.00	20.70	19.17	21.20	18.70	20.15	21.00	20.80	20.90	21.23	18.73	20.53
	Removing 20%	20.70	21.60	21.10	21.90	19.10	20.88	18.50	20.60	20.20	19.40	19.17	19.57
	Removing 30%	22.20	21.90	22.10	22.60	20.20	21.80	22.60	22.70	21.00	22.80	18.47	21.51
	Control	19.70	19.00	19.07	19.50	18.47	19.15	19.80	19.50	18.70	20.70	18.23	19.39
	Mean (A×C)	20.90	20.80	20.36	21.30	19.12	20.50	20.48	20.90	20.20	21.03	18.65	20.25
Tommy	Removing 10%	19.90	20.90	21.60	21.70	19.87	20.79	20.40	21.20	19.90	22.20	18.87	20.51
	Removing 20%	22.30	22.20	21.20	22.70	20.77	21.83	21.67	20.50	21.30	22.90	19.10	21.09
	Removing 30%	23.50	22.90	23.23	23.83	19.80	22.65	22.90	22.80	22.80	23.37	19.47	22.27
	Control	20.90	21.20	20.70	20.57	19.27	20.53	20.50	20.30	18.90	20.57	18.53	19.76
	Mean (A×C)	21.65	21.80	21.68	22.20	19.93	21.45	21.37	21.20	20.73	22.26	18.99	20.91
Removing 10%		20.45	20.80	20.38	21.45	19.28	20.47	20.70	21.00	20.40	21.72	18.80	20.52
Removing 20%		21.50	21.90	21.15	22.30	19.93	21.36	20.08	20.55	20.75	21.15	19.13	20.33
Removing 30%		22.85	22.40	22.67	23.22	20.00	22.23	22.75	22.75	21.90	23.08	18.97	21.89
Control		20.30	20.10	19.88	20.03	18.87	19.84	20.15	19.90	18.80	20.63	18.38	19.57
Mean ©		21.28	21.30	21.02	21.75	19.52	---	20.92	21.05	20.46	21.65	18.82	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate ©	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.46	0.65	0.73	0.92	1.03	1.46	2.06
Season 2013/2014	0.57	0.81	0.91	1.15	1.28	1.81	2.57

(growth cycles) of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons. Length of newly growth was the highest with "Tommy Atkins" mango cultivar as compared to "Keitt" mango cultivar.

With respect to pruning treatments, data clarify that removing 30% of vegetative growth gave significantly the highest values followed by removing 20% and 10% with insignificant between them, while control resulted in significantly the lowest values.

Concerning N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+20+30) with insignificant between them, whereas control produced significantly the lowest values.

According to interaction between type of cultivar and pruning treatments, data show that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth had significantly the highest values, followed by "Keitt" mango cultivar with removing 30% of vegetative growth with insignificant among them, while "Keitt" mango cultivar with remaining pruning treatments resulted in significantly the lowest values.

With respect to interaction between type of cultivar and N fertilization rate, it was found that "Tommy Atkins" mango cultivar with N fertilization rate (50+0+50) had significantly the highest values, followed by N fertilization rate (50+20+30) with insignificant between them, whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data show that removing 30% of vegetative growth with N fertilization rate (50+0+50) recorded the highest values, followed by removing 30% of vegetative growth with N fertilization rate (50+20+30), meanwhile control resulted in significantly the lowest values.

Results of interaction among type of cultivar, pruning treatments and N fertilization rate, revealed that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+0+50) recorded significantly the highest values, whereas "Keitt" and "Tommy Atkins" mango cultivars under control treatments either N fertilization or pruning treatments resulted in significantly the lowest shoot length in both seasons of study.

The obtained results are in harmony with those given by Rakha [13] who mentioned that "Tommy Atkins" mango cv. recorded the highest shoot length, followed by "Keitt" mango cv., while Kent mango cv. recorded the lowest values. As for the effect of pruning, Shaban [15] found that, the highest value of new flushes length of Zebda mango trees was recorded with moderate pruning followed by light pruning then severe pruning. The reduction in length of new flushes under severe pruning may be due to the effect of severe pruning on inducing new flushes. In addition, Falts [16] found that shoot length significantly increased with removing of one-third of branch as compared to control of Keitt mango trees. Regarding effect of N fertilization, Khamis *et al*. [17]

Table 3: Effect of pruning level and N fertilization rate on diameter of newly formed shoots (cm) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

Cultivar (A)	Pruning level (B)	Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	0.67	0.66	0.64	0.68	0.56	0.64	0.69	0.67	0.65	0.70	0.56	0.66
	Removing 20%	0.71	0.70	0.69	0.73	0.57	0.68	0.75	0.74	0.72	0.76	0.55	0.70
	Removing 30%	0.79	0.77	0.74	0.82	0.56	0.73	0.81	0.79	0.78	0.85	0.54	0.75
	Control	0.62	0.60	0.59	0.62	0.51	0.59	0.61	0.61	0.58	0.63	0.51	0.59
	Mean (A×C)	0.70	0.68	0.66	0.71	0.55	0.66	0.72	0.70	0.68	0.74	0.54	0.68
Tommy	Removing 10%	0.64	0.63	0.61	0.65	0.55	0.62	0.67	0.66	0.64	0.69	0.56	0.64
	Removing 20%	0.69	0.67	0.65	0.70	0.56	0.65	0.72	0.70	0.70	0.74	0.57	0.69
	Removing 30%	0.75	0.72	0.71	0.78	0.52	0.70	0.76	0.75	0.74	0.79	0.56	0.72
	Control	0.59	0.57	0.56	0.60	0.51	0.57	0.61	0.59	0.58	0.62	0.51	0.58
	Mean (A×C)	0.67	0.65	0.63	0.68	0.54	0.63	0.69	0.68	0.67	0.71	0.55	0.66
Removing 10%		0.66	0.65	0.63	0.67	0.56	0.63	0.68	0.67	0.65	0.70	0.56	0.65
Removing 20%		0.70	0.69	0.67	0.72	0.56	0.67	0.74	0.72	0.71	0.75	0.56	0.70
Removing 30%		0.77	0.75	0.73	0.80	0.54	0.72	0.79	0.77	0.76	0.82	0.55	0.74
Control		0.61	0.59	0.58	0.61	0.51	0.58	0.61	0.60	0.58	0.63	0.51	0.59
Mean (C)		0.68	0.67	0.65	0.70	0.54	---	0.70	0.69	0.67	0.72	0.55	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.01	0.01	0.02	0.02	0.02	0.03	0.05
Season 2013/2014	0.01	0.01	0.01	0.01	0.02	0.02	0.03

found that soil application of N to mango seedlings considerably and significantly stimulated plant growth causing a great increase in plant height. In addition, Samra *et al.* [18] showed that spraying "Zebda" mango trees with urea at 1% promoted shoot length.

Newly Growth Diameter: Date in Table (3) demonstrated the effect of pruning treatments and N fertilization rate on newly growth diameter of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons.

The biggest significant newly growth diameter was obtained with "Keitt" mango cultivar as compared to "Tommy Atkins" mango cultivar.

Regarding pruning treatments, data clarify that removing 30% of vegetative growth produced significantly the highest values followed by removing 20% and 10% with insignificant between them, while control resulted in significantly the lowest values.

Concerning N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+20+30) with insignificant between them, whereas control were significantly the lowest values.

Regarding interaction between type of cultivar and pruning treatments, data clearly showed that "Keitt" mango cultivar with removing 30% of vegetative growth had significantly the highest values, followed by "Tommy Atkins" mango cultivar with removing 30% of vegetative growth, while "Tommy Atkins" mango cultivar with remaining pruning treatments gave significantly the lowest growth diameter.

With respect to interaction between type of cultivar and N fertilization rate, data showed that "Keitt" mango cultivar with N fertilization rate (50+0+50) had significantly the highest values, followed by N fertilization rate (50+20+30), whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data demonstrated that removing 30% of vegetative growth with N fertilization rate (50+0+50) had significantly the highest values, followed by removing 30% of vegetative growth with N fertilization rate (50+20+30), while control were significantly the lowest in both seasons of study.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, revealed that "Keitt" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas "Keitt" and "Tommy Atkins" mango cultivars under control treatments either N fertilization or pruning treatments had significantly the lowest values.

These results are in harmony with those obtained by Rakha [13] who found that "Keitt" mango cv. recorded the highest shoot thickness, followed by "Tommy Atkins" mango cv., while Kent mango cv. recorded the lowest values. As for the effect of pruning, Falts [16] mentioned that shoot thickness significantly increased with removing of one-third of branch as compared to control of Kitt mango trees. Regarding effect of N fertilization, Khamis *et al.* [17] reported that soil application of N

Table 4: Effect of pruning level and N fertilization rate on leaves number/shoot of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

Cultivar (A)	Pruning level (B)	Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	14.40	14.20	14.13	14.60	13.43	14.15	15.40	15.30	15.23	15.50	14.13	15.11
	Removing 20%	14.70	14.60	14.60	14.80	13.50	14.44	15.93	15.80	15.57	16.20	14.47	15.59
	Removing 30%	15.20	15.13	14.57	15.40	13.20	14.70	16.60	16.40	16.17	16.77	14.13	16.01
	Control	13.80	13.70	15.20	13.87	13.80	14.07	15.13	14.87	14.83	15.20	13.87	14.78
	Mean (A×C)	14.53	14.41	14.63	14.67	13.48	14.34	15.77	15.59	15.45	15.92	14.15	15.38
Tommy	Removing 10%	15.87	16.70	15.80	16.13	15.13	15.93	16.30	16.20	16.17	16.43	15.23	16.07
	Removing 20%	16.50	16.40	16.20	16.70	15.33	16.23	16.80	16.70	16.50	16.83	15.20	16.41
	Removing 30%	17.13	16.87	16.80	17.20	14.97	16.59	17.60	17.40	17.13	17.87	15.03	17.01
	Control	15.60	15.60	15.30	15.83	14.60	15.39	15.80	15.60	15.40	15.70	14.90	15.48
Mean (A×C)		16.28	16.39	16.03	16.47	15.01	16.03	16.63	16.48	16.30	16.71	15.09	16.24
Removing 10%		15.13	15.45	14.97	15.37	14.28	15.04	15.85	15.75	15.70	15.97	14.68	15.59
Removing 20%		15.60	15.50	15.40	15.75	14.42	15.33	16.37	16.25	16.03	16.52	14.83	16.00
Removing 30%		16.17	16.00	15.68	16.30	14.08	15.65	17.10	16.90	16.65	17.32	14.58	16.51
Control		14.70	14.65	15.25	14.85	14.20	14.73	15.47	15.23	15.12	15.45	14.38	15.13
Mean (C)		15.40	15.40	15.33	15.57	14.25	---	16.20	16.03	15.88	16.31	14.62	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate ©	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.59	0.83	0.93	1.18	1.32	1.78	2.64
Season 2013/2014	0.56	0.79	0.89	1.12	1.25	1.77	2.51

to mango seedlings considerably and significantly stimulated plant growth causing a great increase in stem thickness.

Number of Leaves per Newly Growth: Results showed in Table (4) revealed the effect of pruning treatments and N fertilization rate on number of leaves of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons.

Highest significant number of leaves was obtained with "Tommy Atkins" mango cultivar as compared to "Keitt" mango cultivar.

With respect to pruning treatments, data clarify that removing 30% of vegetative growth gave significantly the highest values followed by removing 20% and 10% with insignificant between them, while control resulted in significantly the lowest values.

Regarding N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+20+30) with insignificant between them, whereas control produced significantly the lowest values.

Concerning interaction between type of cultivar and pruning treatments, data show that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth had significantly the highest values, followed by "Keitt" mango cultivar with removing 30% of vegetative growth with insignificant among them, while "Keitt" mango cultivar with remaining pruning treatments resulted in significantly the lowest values.

Regarding to interaction between type of cultivar and N fertilization rate, data revealed that "Tommy Atkins" mango cultivar with N fertilization rate (50+0+50) had significantly the highest values, followed by N fertilization rate (50+20+30) with insignificant between them, whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control produced significantly had the lowest values.

Concerning interaction between type of pruning treatments and N fertilization rate, data demonstrated that removing 30% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed by removing 30% of vegetative growth with N fertilization rate (50+20+30), while control resulted in significantly the lowest values.

With respect to interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that "Tommy Atkins" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas "Keitt" and "Tommy Atkins" mango cultivars under control treatments either N fertilization or pruning treatments resulted in significantly the lowest values.

The obtained results are in agreement with those given by Rakha [13] who found that "Tommy Atkins" mango cv. recorded the highest number of leaves / shoot, followed by "Keitt" mango cv., while Kent mango cv. recorded the lowest values. As for the effect of pruning, Shaban [15] found that the highest number of leaves per flush of Zebda mango trees was recorded with moderate

Table 5: Effect of pruning level and N fertilization rate on leaf area (cm²) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

| Cultivar (A) | Pruning level (B) | Nitrogen Fertilization rate (C) | | | | | | | | | | | |
| | | Season 2012/2013 | | | | | | Season 2013/2014 | | | | | |
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	49.43	52.40	45.37	54.50	40.37	48.41	53.27	46.93	49.20	55.07	38.53	48.60
	Removing 20%	55.67	52.93	55.27	55.07	39.67	51.72	52.50	51.80	50.53	49.13	40.57	48.91
	Removing 30%	58.43	58.27	56.93	59.30	39.50	54.49	53.87	47.83	55.17	60.23	38.13	51.05
	Control	39.67	41.47	42.43	43.77	37.67	41.00	43.23	48.23	44.63	51.03	38.73	45.17
	Mean (A×C)	50.80	51.27	50.00	53.16	39.30	48.91	50.72	48.70	49.88	53.87	38.99	48.43
Tommy	Removing 10%	45.53	41.73	41.23	46.30	40.53	43.07	44.20	51.53	42.90	39.73	39.37	43.55
	Removing 20%	43.87	49.10	41.57	44.17	41.30	44.00	46.10	44.40	43.03	51.40	38.77	44.74
	Removing 30%	54.93	48.40	46.63	53.93	37.37	48.25	48.37	45.70	45.20	54.87	37.23	46.27
	Control	39.57	39.33	40.97	40.33	35.70	39.18	41.93	39.67	39.37	40.33	35.63	39.39
	Mean (A×C)	45.98	44.64	42.60	46.18	38.73	43.63	45.15	45.33	42.63	46.58	37.75	43.49
Removing 10%		47.48	47.07	43.30	50.40	40.45	45.74	48.73	49.23	46.05	47.40	38.95	46.07
Removing 20%		49.77	51.02	48.42	49.62	40.48	47.86	49.30	48.10	46.78	50.27	39.67	46.82
Removing 30%		56.68	53.33	51.78	56.62	38.43	51.37	51.12	46.77	50.18	57.55	37.68	48.66
Control		39.62	40.40	41.70	42.05	36.68	40.09	42.58	43.95	42.00	45.68	37.18	42.28
Mean (C)		48.39	47.95	46.30	49.67	39.01	---	47.93	47.01	46.25	50.23	38.37	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	2.49	3.52	3.93	4.98	5.56	7.78	11.12
Season 2013/2014	2.34	3.31	3.70	4.68	5.24	7.40	10.47

pruning followed by light pruning then severe pruning. The reduction in length of new flushes under severe pruning may be due to the effect of severe pruning on inducing new flushes. Also, Falts [16] mentioned that number of leaves/shoot significantly increased with removing of one-third of branch as compared to control of Kitt mango trees. Regarding effect of N fertilization, Khamis *et al*. [17] reported that soil application of N to mango seedlings considerably and significantly stimulated plant growth causing a great increase in leaves number / plant. In addition, Samra *et al*. [18] showed that spraying "Zebda" mango trees with urea at 1% promoted number of leaves/ shoots.

Leaf Area: Date generated in Table (5) showed the effect of pruning treatments and N fertilization rate on leaf area of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons.

Highest significant increase of leave area was obtained with "Keitt" mango cultivar as compared to "Tommy Atkins" mango cultivar.

Concerning pruning treatments, data clarify that removing 30% of vegetative growth induced significantly the highest values followed by removing 20% and 10% with insignificant between them, while control significantly had the lowest values.

With respect to N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+20+30) with insignificant between them, whereas control were significantly the lowest values.

Regarding interaction between type of cultivar and pruning treatments, data clearly showed that "Keitt" mango cultivar with removing 30% of vegetative growth had significantly the highest values, followed by "Tommy Atkins" mango cultivar with removing 30% of vegetative growth, while "Tommy Atkins" mango cultivar with remaining pruning treatments resulted in significantly the lowest values.

Concerning interaction between type of cultivar and N fertilization rate, as well as interaction between type of pruning treatment and N fertilization rate, data showed that "Keitt" mango cultivar with N fertilization rate (50+0+50) gave significantly the highest values, followed by N fertilization rate (50+20+30), whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control produced significantly the lowest values.

Regarding interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that "Keitt" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas "Keitt" and "Tommy Atkins" mango cultivars under control treatments either N fertilization or pruning treatments resulted in significantly the lowest values.

These results are supported with those obtained by Rakha [13] who found that "Tommy Atkins" mango cv. recorded the highest leaf width, followed by Kent mango cv., while "Keitt" mango cv. recorded the lowest values. Falts [16] found that leaf area significantly increased with removing of one-third of branch as compared to control of Kitt mango trees. Regarding effect of N fertilization,

Table 6: Effect of pruning level and N fertilization rate on leaf N content (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

Cultivar (A)	Pruning level (B)	Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	1.58	1.61	1.35	1.44	0.93	1.38	1.65	1.33	1.48	1.50	1.05	1.40
	Removing 20%	1.53	1.71	1.62	1.87	1.03	1.55	1.60	1.55	1.69	1.58	0.86	1.45
	Removing 30%	1.52	1.18	1.11	1.57	0.89	1.25	1.61	1.59	1.31	1.45	0.98	1.39
	Control	1.56	1.33	1.29	1.45	0.74	1.27	1.32	1.48	1.17	1.32	0.93	1.25
	Mean (A×C)	1.54	1.46	1.34	1.58	0.90	1.37	1.54	1.49	1.41	1.46	0.95	1.37
Tommy	Removing 10%	1.50	0.95	1.34	1.36	1.03	1.24	1.16	1.51	1.12	1.04	0.92	1.15
	Removing 20%	1.33	1.37	1.58	2.05	0.98	1.46	1.38	1.57	1.36	1.45	1.01	1.35
	Removing 30%	1.03	1.45	0.98	1.56	0.93	1.19	1.11	1.02	1.26	1.16	0.89	1.09
	Control	1.40	1.05	1.11	1.67	0.74	1.19	1.04	1.05	1.21	1.26	0.47	1.00
	Mean (A×C)	1.32	1.20	1.25	1.66	0.92	1.27	1.17	1.29	1.24	1.23	0.82	1.15
Removing 10%		1.54	1.28	1.35	1.40	0.98	1.31	1.40	1.42	1.30	1.27	0.98	1.28
Removing 20%		1.43	1.54	1.60	1.96	1.01	1.51	1.49	1.56	1.52	1.51	0.94	1.40
Removing 30%		1.27	1.32	1.04	1.57	0.91	1.22	1.36	1.31	1.29	1.31	0.94	1.24
Control		1.48	1.19	1.20	1.56	0.74	1.23	1.18	1.27	1.19	1.29	0.70	1.13
Mean (C)		1.43	1.33	1.30	1.62	0.91	---	1.36	1.39	1.32	1.34	0.89	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate ©	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.09	0.13	0.15	0.19	0.21	0.30	0.42
Season 2013/2014	0.12	0.17	0.19	0.24	0.27	0.38	0.53

Khamis *et al*. [17] found that soil application of N to mango seedlings considerably and significantly stimulated plant growth causing a great increase in leaf area and assimilation area.

Nitrogen Leaf Content (%): Date in Table (6) showed the effect of pruning treatments and N fertilization rate on leave nitrogen content of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons. Highest significant nitrogen was obtained with "Keitt" mango cultivar as compared to "Tommy Atkins" mango cultivar in both seasons of study.

Regarding pruning treatments, data clarify that removing 20% of vegetative growth induced significantly the highest values followed by removing 10%, while control resulted in significantly the lowest values.

Concerning N fertilization rate, the highest significant values was attained by N fertilization rate (50+0+50) in the first season, N fertilization rate (50+20+30) in the second season, whereas control produced significantly the lowest values.

Concerning interaction between type of cultivar and pruning treatments, data show that "Keitt" mango cultivar with removing 20% of vegetative growth had significantly the highest values, followed by "Keitt" mango cultivar with removing 10% of vegetative growth, while "Tommy Atkins" mango cultivar with remaining pruning resulted in significantly the lowest values.

With respect to interaction between type of cultivar and N fertilization rate, data show that "Keitt" mango cultivar with N fertilization rate (50+0+50) had significantly the highest values, followed by N fertilization rate (50+20+30) with insignificant between them, whereas "Keitt" and "Tommy Atkins" mango cultivars under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data showed that the highest significant values was attained by removing 20% of vegetative growth with N fertilization rate (50+0+50) in the first season, removing 20% of vegetative growth with N fertilization rate (50+30+20) in the second season only, while control either N fertilization or pruning treatments had significantly the lowest values.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data show that the highest significant values was attained by "Keitt" and "Tommy Atkins" mango cultivars with removing 20% of vegetative growth under N fertilization rate (50+0+50) in the first season, "Keitt" mango cultivar with removing 20% of vegetative growth under N fertilization rate (0+50+50) in the second season, whereas "Tommy Atkins" cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest values.

Phosphorus Leaf Content (%): The data recorded in Table (7) showed the effect of pruning treatments and N fertilization rate on phosphorus of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons. No significant difference was observed between cultivars in both seasons of study.

Table 7: Effect of pruning level and N fertilization rate on leaf P content (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

Cultivar (A)	Pruning level (B)	Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	0.10	0.13	0.15	0.16	0.16	0.14	0.15	0.16	0.19	0.14	0.11	0.15
	Removing 20%	0.14	0.14	0.12	0.21	0.10	0.14	0.13	0.14	0.15	0.13	0.17	0.14
	Removing 30%	0.14	0.14	0.17	0.13	0.13	0.14	0.20	0.10	0.18	0.13	0.16	0.15
	Control	0.11	0.10	0.11	0.16	0.08	0.11	0.13	0.14	0.13	0.11	0.12	0.13
	Mean (A×C)	0.12	0.13	0.14	0.17	0.12	0.13	0.15	0.14	0.16	0.13	0.14	0.14
Tommy	Removing 10%	0.13	0.10	0.17	0.07	0.13	0.12	0.10	0.15	0.10	0.17	0.11	0.13
	Removing 20%	0.13	0.15	0.17	0.13	0.13	0.14	0.16	0.07	0.11	0.11	0.11	0.11
	Removing 30%	0.11	0.11	0.12	0.15	0.14	0.13	0.14	0.12	0.12	0.13	0.16	0.13
	Control	0.12	0.16	0.16	0.11	0.11	0.13	0.10	0.15	0.12	0.15	0.14	0.13
	Mean (A×C)	0.12	0.13	0.16	0.12	0.13	0.13	0.13	0.12	0.11	0.14	0.13	0.13
Removing 10%		0.12	0.12	0.16	0.12	0.15	0.13	0.12	0.15	0.14	0.16	0.11	0.14
Removing 20%		0.14	0.15	0.15	0.17	0.12	0.14	0.15	0.11	0.13	0.12	0.14	0.13
Removing 30%		0.13	0.13	0.15	0.14	0.14	0.14	0.17	0.11	0.15	0.13	0.16	0.14
Control		0.12	0.13	0.14	0.14	0.10	0.12	0.12	0.15	0.13	0.13	0.13	0.13
Mean (C)		0.12	0.13	0.15	0.14	0.12	---	0.14	0.13	0.14	0.13	0.14	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	N.S	0.02	0.02	0.02	0.03	0.04	0.05
Season 2013/2014	N.S	N.S	N.S	0.04	0.04	N.S	0.09

With respect to pruning treatments, data clarify that all pruning treatments induced significantly the highest values as compared to control, which it resulted in significantly the lowest values in the first season. No significant difference was observed among pruning treatments in the second season.

Regarding N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) and (0+50+50), whereas control produced significantly the lowest values in the first season. No significant difference was observed among N fertilization treatments in the second season.

Concerning interaction between type of cultivar and pruning treatments, data show that "Keitt" and "Tommy Atkins" mango cultivars with all pruning treatments had significantly the highest values as compared to "Keitt" mango cultivar with remaining of vegetative growth and "Tommy Atkins" mango cultivar with removing 10% of vegetative growth in the first season "Tommy Atkins" mango cultivar with removing 20% of vegetative growth in the second season which were resulted in significantly the lowest values.

With respect to interaction between type of cultivar and N fertilization rate, data show that "Keitt" and "Tommy Atkins" mango cultivars with all N fertilization treatments had significantly the highest values as compared to "Keitt" mango cultivar with N fertilization rates (50+20+30) and "Tommy Atkins" mango cultivar with N fertilization rates (50+20+30) and (50+0+50) in the first season. "Tommy Atkins" mango cultivar with N fertilization rates (0+50+50) resulted in significantly the lowest values in the second season.

Regarding interaction between type of pruning treatments and N fertilization rate, data show that the highest significant values was attained by removing 20% of vegetative growth with N fertilization rate (50+0+50), while control either N fertilization or pruning treatments gave significantly the lowest values in the first season. No significant difference was observed among pruning and N fertilization treatments in the second season.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data show that the highest significant values was attained by "Keitt" mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) whereas "Tommy Atkins" mango cultivar with removing 10% of vegetative growth under N fertilization rate (50+0+50) resulted in significantly the lowest values in the first season, "Keitt" mango cultivar with removing 30% of vegetative growth under N fertilization rate (50+20+30) whereas "Tommy Atkins" mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+30+20) resulted in significantly the lowest values in the second season.

Potassium Leaf Content (%): The effect of pruning treatments and N fertilization rate on potassium of "Keitt" and "Tommy Atkins" mango cultivars during 2012-2013 and 2013-2014 seasons as shown in Table (8) results indicated that no significant difference was observed between cultivars.

Concerning to pruning treatments, data clarify that all pruning treatments induced significantly the highest values as compared to control, which it resulted in significantly the lowest values.

Table 8: Effect of pruning level and N fertilization rate on leaf K content (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

Cultivar (A)	Pruning level (B)	Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
		(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)	(50+20+30) N	(50+30+20) N	(0+50+50) N	(50+0+50) N	Control	Mean (AxB)
Keitt	Removing 10%	0.90	0.73	1.10	0.90	0.87	0.90	1.10	0.83	0.70	1.13	1.03	0.96
	Removing 20%	1.10	0.87	0.77	1.00	0.90	0.93	1.13	0.93	0.87	1.17	0.70	0.96
	Removing 30%	1.10	1.10	1.13	1.13	1.00	1.09	0.57	0.57	0.90	0.77	0.60	0.68
	Control	0.87	0.87	0.80	0.83	0.73	0.82	0.97	0.63	0.90	0.97	0.50	0.79
	Mean (A×C)	0.99	0.89	0.95	0.97	0.88	0.94	0.94	0.74	0.84	1.01	0.71	0.85
Tommy	Removing 10%	0.87	0.93	0.93	1.00	0.90	0.93	1.03	1.07	1.00	1.03	1.03	1.03
	Removing 20%	0.83	0.70	1.03	0.70	1.00	0.85	1.03	0.70	0.73	0.97	1.00	0.89
	Removing 30%	1.13	1.23	0.97	0.90	0.77	1.00	0.90	1.07	0.93	0.90	0.70	0.90
	Control	1.03	0.70	0.93	0.87	0.93	0.89	0.73	0.73	0.97	0.70	0.77	0.78
	Mean (A×C)	0.97	0.89	0.97	0.87	0.90	0.92	0.93	0.89	0.91	0.90	0.88	0.90
Removing 10%		0.88	0.83	1.02	0.95	0.88	0.91	1.07	0.95	0.85	1.08	1.03	1.00
Removing 20%		0.97	0.78	0.90	0.85	0.95	0.89	1.08	0.82	0.80	1.07	0.85	0.92
Removing 30%		1.12	1.17	1.05	1.02	0.88	1.05	0.73	0.82	0.92	0.83	0.65	0.79
Control		0.95	0.78	0.87	0.85	0.83	0.86	0.85	0.68	0.93	0.83	0.63	0.79
Means (C)		0.98	0.89	0.96	0.92	0.89	---	0.93	0.82	0.88	0.95	0.79	---

LSD at 5%	Cultivar (A)	Pruning Level (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	N.S	N.S	N.S	0.27	N.S	N.S	N.S
Season 2013/2014	0.19	0.16	N.S	0.23	0.26	0.37	0.52

Regarding N fertilization rate, no significant difference was observed among N fertilization treatments in both seasons of study.

With regard to interaction between type of cultivar and pruning treatments, data show that "Keitt" and "Tommy Atkins" mango cultivars with all pruning treatments had significantly the highest values as compared to "Keitt" mango cultivar with remaining of vegetative growth in the first season, "Keitt" mango cultivar with removing 30% of vegetative growth in the second season which, resulted in significantly the lowest values.

Concerning interaction between type of cultivar and N fertilization rate, data show that "Keitt" mango cultivar with N fertilization rates (50+0+50) had significantly the highest values, while "Keitt" mango cultivar with control treatment resulted in significantly the lowest values in the second season. No significant difference was observed among cultivars and N fertilization treatments in the first season.

Regarding interaction between type of pruning treatments and N fertilization rate, data show that the highest significant values was attained by removing 20% of vegetative growth with N fertilization rate (50+20+30), while control either N fertilization or pruning treatments resulted in significantly the lowest values in the second season. No significant difference was observed among pruning and N fertilization treatments in the first season.

As for the interaction among type of cultivar, pruning treatments and N fertilization rate, data show that the highest significant values was attained by "Keitt" mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) whereas "Keitt" mango cultivar with control either N fertilization or pruning treatments resulted in significantly the lowest values in the second season. No significant difference was observed among cultivars, pruning and N fertilization treatments in the first season.

In the present study, results are in agreement with those given by Falts [16] who found that leaf N, P and K content significantly increased with removing of one-third of branch as compared to control of Kitt mango trees. Regarding effect of N fertilization, Shah *et al*. [19] mentioned that nitrogen fertilization in April increased nitrogen in leaves of mango cv. Dusehri. In addition, Reddy *et al*. [20] reported that N level in plant was positively related to its application rate, of Totapuri mango trees. Moreover, Khamis *et al*. [17] found that supplying mango seedlings with N fertilizers increased nitrogen levels meanwhile decreased potassium and phosphorus levels in different plant organs.

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