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Effect of Pruning and Nitrogen Fertilization Rates on the Productivity of "Keitt" and "Tommy Atkins" Mango Trees

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Abstract: This experiment was carried out during 2012-2013 and 2013-2014 seasons in a private orchard located at Cairo Alexandria Desert Road, 62 km, Egypt, on 9 years old "Keitt" and "Tommy Atkins" mango cultivars trees (*Mangifera indica* .L) budded on white Sukary seedling rootstocks. The experimental trees of both cultivars received three levels of pruning after harvest in September as follows: remove 10% or 20% or 30% of the total vegetative growth in addition to control (without pruning) beside different rates of nitrogen fertilizers application at the different stages of trees growth (After harvesting + Beginning of bud differentiation + From the fruit set until fruit maturity) as follows (50+20+30), (50+30+20), (0+50+30), (50+0+50) in addition to control (fertilization program recommended in the farm). Pruning and nitrogen fertilization rates were applied individually or in combination. The results indicated that, Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) was the best treatment for achieving the best yield with its components as well as the best physical and chemical characteristics of fruits included fruit weight, firmness, total soluble solids, total sugars and acidity. On the other hand, Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments had significantly the lowest values of these ones in both seasons of study.

Key words: Keitt · Tommy Atkins · Mango · Pruning · Fertilization · Yield · Fruit · Quality total soluble solids · Total sugars and acidity

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]. In Egypt, mango is considered as one of the main fruits which rank the third after citrus and grapes. It is worthy to be mentioned that mango introduced to Egypt in 1825 year. The total acreage of mango in Egypt increased to reach about 289288 feddans producing about 1066404 tons [2]. 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. 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].

The fruit production and quality depends on several factors prevailing during their growth and development. Amongst the several factors, pruning is an important cultural operation for obtaining quality yield from the fruiting trees, which involves judicious removal of

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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]. Sunlight not only influences the flowering and fruit set, but also enhances quality and color development of fruits [6]. Both the intrinsic and extrinsic attributes are integral parts of fruit quality; previously, several studies have been conducted on pruning in the mango tree in relation to better light penetration, fruit set and yield in pruned trees [7].

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 [8]. 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 [9]. Hence, application of fertilizer N resulting in higher biomass is commonly increased. Optimum rate and time of N application can enhance yield productivity and nutrient use efficiencies while reducing the environmental pollution [10, 11].

Therefore, the scope 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 yield and fruit quality attributes of Keitt and Tommy Atkins mango cultivars.

MATERIALS AND METHODS

This experiment 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).

This experiment consisted of 40 treatments and each treatment contained three replicates as one tree for each replicate.

The Following Characters Were Estimated:

Initial Fruit Set: Was estimated within 15 days after petal fall as number of fruits per tree.

Fruit Retention (%): Was calculated at harvest using the following equation:

$$\text{Fruit retention (\%)} = \frac{\text{Number of fruits per tree at harvest}}{\text{Initial number of fruit set per tree}} \text{ x } 100$$

Yield (Kg/Tree): Was estimated at harvest by multiplying fruit number per tree X average fruit weight.

At maturity stage of Keitt and Tommy Atkins mango fruits, described by Hussein [12], three fruits were taken randomly from each replicate for determination of fruit weight (g); fruit firmness (lb/inch^2) by using penetrometer; fruit TSS (%) by using hand Carl Zeis refractometer; fruit acidity (%) according to A.O.A.C [13] and total sugars (%) by using picric acid method as described by Malik [14].

Statistical Analysis: The obtained data were subject to analysis of variance. The means values were compared using LSD at 5% levels. The data were tabulated and statistically analyzed according to Complete Randomized Blocks design [15]. As cultivar was factor A, levels of pruning was factor B and rates of nitrogen fertilizers application were factor C. the percentages were transformed to arcsine to find the binomial percentages according to Steel and Torrie [16].

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

	Application stage		
Nitrogen fertilizer Rate	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		

RESULTS AND DISCUSSION

Initial Fruit Set: Data in Table (1) showed the effect of pruning treatments and N fertilization rate on initial fruit set of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Highest significant number of fruit set was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar

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

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 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, removing either 10% or 30% of vegetative growth resulted in significantly the lowest fruit set.

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), whereas Tommy Atkins mango cultivar under N fertilization control produced significantly the lowest values.

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

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data demonstrated that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest fruit set.

Fruit Retention (%): The results shown in Table (2) indicated the effect of pruning treatments and N fertilization rate on fruit retention % of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Highest significant fruit retention % was obtained with Tommy Atkins mango cultivar as compared to Keitt mango cultivar.

Concerning to pruning treatments, data clarify that removing 20% of vegetative growth induced significantly the highest values followed by removing 10% with insignificant between them, while control resulted in significantly the lowest fruit retention (%).

With respect N fertilization rate, the highest significant values was attained by N fertilization rates (50+0+50) followed by N fertilization rate (50+30+20) 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 20% of vegetative growth had significantly the highest values, followed by Tommy Atkins mango cultivar with removing 10% of vegetative growth with insignificant between them, while Keitt and Tommy Atkins mango cultivars with remaining pruning resulted in significantly the lowest fruit retention (%).

Regarding to interaction between type of cultivar and N fertilization rate, data show 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), whereas Tommy Atkins and Keitt mango cultivars under N fertilization control produced significantly the lowest fruit retention (%).

Table 1: Effect of pruning severity and N fertilization rate on initial fruit set of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

		Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	52.00	44.00	51.67	46.33	42.00	47.20	53.67	49.67	49.00	46.67	43.33	48.47
	Removing 20%	53.67	52.00	51.33	54.00	48.33	51.87	51.00	53.67	43.00	52.00	43.67	48.67
	Removing 30%	45.00	43.00	43.00	48.33	44.67	44.80	47.67	43.67	46.67	47.33	44.00	45.87
	Control	41.67	36.67	42.00	52.00	43.00	43.07	45.00	45.00	47.67	47.33	38.00	44.60
Mean (A×C)		48.08	43.92	47.00	50.17	44.50	46.73	49.33	48.00	46.58	48.33	42.25	46.90
Tommy	Removing 10%	43.33	41.67	39.33	46.00	38.33	41.73	45.67	45.00	45.33	46.33	38.33	44.13
	Removing 20%	43.33	46.00	43.67	50.33	44.33	45.53	43.33	46.00	48.33	49.00	37.67	44.87
	Removing 30%	43.67	41.00	44.07	42.00	39.67	42.08	46.33	48.00	45.67	40.67	38.67	43.87
	Control	45.00	43.00	45.33	41.00	42.00	43.27	42.67	39.33	38.33	39.67	39.67	39.93
Mean (A×C)		43.83	42.92	43.10	44.83	41.08	43.15	44.50	44.58	44.42	43.92	38.58	43.20
Removing 10%		47.67	42.83	45.50	46.17	40.17	44.47	49.67	47.33	47.17	46.50	40.83	46.30
Removing 20%		48.50	49.00	47.50	52.17	46.33	48.70	47.17	49.83	45.67	50.50	40.67	46.77
Removing 30%		44.33	42.00	43.53	45.17	42.17	43.44	47.00	45.83	46.17	44.00	41.33	44.87
Control		43.33	39.83	43.67	46.50	42.50	43.17	43.83	42.17	43.00	43.50	38.83	42.27
Mean (C)		45.96	43.42	45.05	47.50	42.79	---	46.92	46.29	45.50	46.13	40.42	---

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	2.19	3.10	3.47	3.49	4.90	6.94	9.81
Season 2013/2014	1.98	2.81	3.14	3.97	4.44	6.27	8.87

Table 2: Effect of pruning severity and N fertilization rate on fruit retention % of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

		Nitrogen Fertilization rate (C)											
		Season 2012/2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	48.33	64.00	48.33	58.67	41.33	52.13	54.00	60.33	49.00	71.67	39.33	54.87
	Removing 20%	58.33	59.33	55.00	66.33	43.00	56.40	60.00	55.67	63.33	69.00	38.33	57.27
	Removing 30%	57.67	52.00	52.33	56.33	40.00	51.67	58.33	73.00	41.67	53.00	42.00	53.60
	Control	49.33	56.33	42.33	39.67	44.33	46.40	55.00	74.67	40.33	53.00	45.67	53.73
Mean (A×C)		53.42	57.92	49.50	55.25	42.17	51.65	56.83	65.92	48.58	61.67	41.33	54.87
Tommy	Removing 10%	67.33	67.33	64.00	58.67	49.00	61.27	60.67	60.00	48.67	63.00	51.33	56.73
	Removing 20%	74.67	65.67	67.00	73.00	41.00	64.27	78.67	70.67	66.33	66.00	43.67	65.07
	Removing 30%	60.00	54.33	53.67	67.33	44.67	56.00	61.67	47.67	57.00	67.67	46.33	56.07
	Control	47.00	55.33	43.00	55.67	35.33	47.27	54.33	54.33	46.33	60.00	47.33	52.47
Mean (A×C)		62.25	60.67	56.92	63.67	42.50	57.20	63.83	58.17	54.58	64.17	47.17	57.58
Removing 10%		57.83	65.67	56.17	58.67	45.17	56.70	57.33	60.17	48.83	67.33	45.33	55.80
Removing 20%		66.50	62.50	61.00	69.67	42.00	60.33	69.33	63.17	64.83	67.50	41.00	61.17
Removing 30%		58.83	53.17	53.00	61.83	42.33	53.83	60.00	60.33	49.33	60.33	44.17	54.83
Control		48.17	55.83	42.67	47.67	39.83	46.83	54.67	64.50	43.33	56.50	46.50	53.10
Means (C)		57.83	59.29	53.21	59.46	42.33	---	60.33	62.04	51.58	62.92	44.25	---

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	3.03	4.29	4.79	6.06	6.78	9.59	13.56
Season 2013/2014	2.53	3.57	3.99	5.05	5.65	7.99	11.30

With respect to interaction between type of pruning treatments and N fertilization rate, data showed that removing 20% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed by removing 20% of vegetative growth with N fertilization rate (50+20+30) with insignificant between them, while control either N fertilization or pruning treatments resulted in significantly the lowest values.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data demonstrated that Tommy Atkins mango cultivar with removing 20% of vegetative growth under N fertilization rates either (50+0+50) or (50+20+30) induced significantly the highest values, whereas Keitt cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest fruit retention (%).

Table 3: Effect of pruning severity and N fertilization rate on yield (kg/ tree) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

		Nitrogen Fertilization rate (C)											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	22.33	22.53	19.85	24.57	10.57	19.97	26.76	25.96	20.16	30.10	11.47	22.89
	Removing 20%	33.61	27.43	26.67	40.94	11.41	28.01	34.62	29.14	25.93	42.59	10.14	28.48
	Removing 30%	19.91	16.39	16.33	21.92	8.93	16.70	22.79	24.00	14.80	20.87	10.38	18.57
	Control	14.82	13.85	12.04	14.87	8.42	12.80	12.76	14.73	13.47	15.21	8.21	12.88
	Mean (A×C)	22.67	20.05	18.72	25.58	9.84	19.37	24.24	23.46	18.59	27.19	10.05	20.70
Tommy	Removing 10%	10.88	9.87	9.34	10.44	19.51	12.01	12.08	11.68	7.08	13.25	5.57	9.93
	Removing 20%	13.63	12.78	11.45	17.05	4.77	11.94	15.73	14.46	14.59	15.47	5.03	13.06
	Removing 30%	9.42	7.50	7.82	9.95	4.29	7.80	10.53	8.74	9.45	11.35	5.09	9.03
	Control	6.65	7.40	5.66	7.58	3.57	6.17	5.99	7.10	5.65	8.15	6.50	6.68
	Mean (A×C)	10.14	9.39	8.57	11.26	8.04	9.48	11.08	10.49	9.19	12.05	5.55	9.67
Removing 10%		16.60	16.20	14.59	17.51	15.04	15.99	19.42	18.82	13.62	21.67	8.52	16.41
Removing 20%		23.62	20.11	19.06	28.99	8.09	19.97	25.18	21.80	20.26	29.03	7.59	20.77
Removing 30%		14.67	11.95	12.08	15.94	6.61	12.25	16.66	16.37	12.12	16.11	7.74	13.80
Control		10.73	10.62	8.85	11.23	6.00	9.49	9.38	10.92	9.56	11.68	7.35	9.78
	Mean (C)	16.41	14.72	13.65	18.42	8.94	---	17.66	16.98	13.89	19.62	7.80	---

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	1.76	2.48	2.78	3.51	3.93	5.56	7.86
Season 2013/2014	2.15	3.03	3.39	4.29	4.80	6.78	9.59

Yield (Kg/Tree): Data in Table (3) indicated the effect of pruning treatments and N fertilization rate on yield of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons. The highest significant yield was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar in both seasons of study.

Concerning to pruning treatments, data clarify that removing 20% of vegetative growth induced significantly the highest values followed by removing 10% with insignificant between them, while control resulted in significantly the lowest yield per tree.

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 had significantly the lowest values.

With respect to interaction between type of cultivar and pruning treatments, data showed 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 yield per tree.

Concerning 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), whereas Tommy Atkins mango cultivar under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data showed that removing 20% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed 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 yield per tree.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data indicated that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest values.

These results are in harmony with those obtained by Rakha [17] who found that Keitt mango cv. recorded the highest percentage of initial fruit setting and yield followed by Kent mango cv., while Tommy Atkins mango cv. recorded the lowest percentage. On the other side, Tommy Atkins cv. had the highest values of fruit retention followed by Keitt cv., while Kent cv. had the lowest values. As for the effect of pruning, Shaban [7] found that 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 of Zebda mango trees. Increasing number of fruits per tree by pruning may be due to inducing number of vegetative flushes and number of panicles per shoot.

Table 4: Effect of pruning severity and N fertilization rate on fruit weight (g) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

		Nitrogen Fertilization rate (C)											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	893.33	865.33	794.33	910.33	622.33	817.13	923.00	895.33	840.33	940.67	717.33	863.33
	Removing 20%	1072.67	992.67	952.67	1148.00	658.67	964.93	1194.00	982.33	960.67	1218.00	676.00	1006.20
	Removing 30%	786.33	734.00	742.67	812.00	595.67	734.13	824.00	766.00	765.67	835.00	623.00	762.73
	Control	717.33	683.00	708.67	731.67	546.00	677.33	709.33	713.00	697.33	744.33	535.67	679.93
	Mean (A×C)	867.42	818.75	799.58	900.50	605.67	798.38	912.58	839.17	816.00	934.50	638.00	828.05
Tommy	Removing 10%	375.33	352.67	373.67	387.00	258.00	349.33	447.67	432.67	322.00	457.00	288.33	389.53
	Removing 20%	426.00	412.33	395.00	465.00	265.33	392.73	462.67	447.33	456.00	483.67	308.33	431.60
	Removing 30%	362.67	341.33	335.33	357.00	243.00	327.87	388.67	380.33	363.33	415.33	273.00	364.13
	Control	316.67	312.33	298.00	334.67	223.33	297.00	347.67	333.33	320.33	344.67	263.67	321.93
	Mean (A×C)	370.17	354.67	350.50	385.92	247.42	341.73	411.67	398.42	365.42	425.17	283.33	376.80
Removing 10%		634.33	609.00	584.00	648.67	440.17	583.23	685.33	664.00	581.17	698.83	502.83	626.43
Removing 20%		749.33	702.50	673.83	806.50	462.00	678.83	828.33	714.83	708.33	850.83	492.17	718.90
Removing 30%		574.50	537.67	539.00	584.50	419.33	531.00	606.33	573.17	564.50	625.17	448.00	563.43
Control		517.00	497.67	503.33	533.17	384.67	487.17	528.50	523.17	508.83	544.50	399.67	500.93
	Mean (C)	618.79	586.71	575.04	643.21	426.54	----	662.13	618.79	590.71	679.83	460.67	----

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	31.96	45.20	50.53	63.92	71.47	101.07	142.93
Season 2013/2014	36.25	51.27	57.32	72.51	81.07	114.65	162.13

Also, Sanjay *et al.* [18] found that the fruit drop reduced significantly with severe pruning, which was lower than the control of 'Amrapali', 'Mallika' and 'Dashehari' mango cultivars. Moreover, Falts [19] found that fruit number/tree increased with removing of one-third of branch as compared to control of Keitt mango trees. Also, García *et al.* [20] found that pruning treatments increased fruit yield of Ataulfo mango cultivar as compared with un-pruned trees. Regarding effect of N fertilization, Umesh *et al*. [21] found that foliar application of urea on mango "Amrapali" at 2.5% gave the maximum number of fruits per tree. Moreover, Amro *et al*. [22] reported that foliar application of Urea at 3% enhanced fruit set percentage and fruit retention percentage of mango trees cv. Fagri Kalan. Also, Samra *et al*. [23] showed that spraying "Zebda" mango trees with urea at 1% increased yield/tree.

Fruit Weight: Data in Table (4) showed effect of pruning treatments and N fertilization rate on fruit weight of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Highest significant fruit weight was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar in both seasons of study.

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

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 fruit weight.

Concerning interaction between type of cultivar and pruning treatments, data showed 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 demonstrated 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 Tommy Atkins mango cultivar under N fertilization control produced significantly the lowest fruit weight.

Regarding interaction between type of pruning treatments and N fertilization rate, data showed that removing 20% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed 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.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data indicated that Keitt mango cultivar with removing 20% of vegetative

Table 5: Effect of pruning severity and N fertilization rate on fruit firmness (lb/inch^2) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

		Nitrogen Fertilization rate ©											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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	22.00	21.00	22.00	17.00	20.60	24.00	23.00	23.00	26.00	19.33	23.07
	Removing 20%	24.00	24.33	23.00	25.00	18.00	22.87	24.33	25.00	25.00	27.00	19.00	24.07
	Removing 30%	21.00	19.67	19.00	20.00	17.67	19.47	21.00	20.00	20.33	22.00	18.00	20.27
	Control	18.00	19.00	20.00	19.00	16.33	18.47	20.00	20.00	21.00	19.00	17.00	19.40
Mean (A×C)		21.00	21.25	20.75	21.50	17.25	20.35	22.33	22.00	22.33	23.50	18.33	21.70
Tommy	Removing 10%	19.00	17.33	17.00	20.33	13.67	17.47	18.00	19.00	18.00	20.00	19.00	18.80
	Removing 20%	20.00	19.67	19.33	21.00	14.33	18.87	21.67	20.00	21.00	22.33	17.33	20.47
	Removing 30%	17.00	16.33	17.00	18.00	13.33	16.33	20.00	19.67	20.00	21.33	16.00	19.40
	Control	16.00	15.33	15.00	16.33	12.33	15.00	17.33	18.00	16.33	18.33	15.33	17.07
Mean (A×C)		18.00	17.17	17.08	18.92	13.42	16.92	19.25	19.17	18.83	20.50	16.92	18.93
Removing 10%		20.00	19.67	19.00	21.17	15.33	19.03	21.00	21.00	20.50	23.00	19.17	20.93
Removing 20%		22.00	22.00	21.17	23.00	16.17	20.87	23.00	22.50	23.00	24.67	18.17	22.27
Removing 30%		19.00	18.00	18.00	19.00	15.50	17.90	20.50	19.83	20.17	21.67	17.00	19.83
Control		17.00	17.17	17.50	17.67	14.33	16.73	18.67	19.00	18.67	18.67	16.17	18.23
Means (C)		19.50	19.21	18.92	20.21	15.33	---	20.79	20.58	20.58	22.00	17.63	---

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	1.49	2.11	2.36	2.99	3.43	4.27	6.68
Season 2013/2014	1.64	2.32	2.59	3.28	3.67	5.18	7.33

growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest.

Fruit Firmness: Data in Table (5) clearly showed the effect of pruning treatments and N fertilization rate on fruit firmness of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Highest significant fruit firmness was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar in both seasons of study.

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

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.

Regarding interaction between type of cultivar and pruning treatments, data showed 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 fruit firmness.

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 Tommy Atkins mango cultivar under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, removing 20% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed 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 fruit firmness.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest values fruit firmness.

The obtained results are in general agreement with those given by Rakha [17] who found that Keitt mango cv. recorded the highest fruit weight, followed by Kent mango cv., while Tommy Atkins mango cv. recorded the lowest values.

Table 6: Effect of pruning severity and N fertilization rate on fruit TSS (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

		Nitrogen Fertilization rate (C)											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	9.7	9.50	9.40	9.60	8.20	9.28	10.13	9.87	9.60	10.30	8.80	9.74
	Removing 20%	10.10	9.90	9.80	10.30	8.30	9.68	10.60	10.40	10.20	10.87	8.60	10.13
	Removing 30%	9.20	9.07	8.80	9.33	8.40	8.96	9.50	9.40	9.30	9.70	9.03	9.39
	Control	8.70	8.50	8.40	8.87	8.13	8.52	8.93	9.13	8.80	9.13	8.27	8.85
Mean (A×C)		9.43	9.24	9.10	9.53	8.26	9.11	9.79	9.70	9.48	10.00	8.68	9.53
Tommy	Removing 10%	8.50	8.40	8.40	8.60	7.60	8.30	9.20	8.87	8.83	9.13	8.20	8.85
	Removing 20%	9.10	8.83	8.90	7.20	7.70	8.35	9.40	9.30	9.20	9.60	8.40	9.18
	Removing 30%	8.20	8.07	8.20	8.30	7.50	8.05	8.60	8.50	8.40	8.70	8.10	8.46
	Control	7.80	7.70	7.60	7.93	7.30	7.67	8.30	8.30	8.23	8.50	7.90	8.25
Mean (A×C)		8.40	8.25	8.28	8.01	7.53	8.09	8.88	8.74	8.67	8.98	8.15	8.68
Removing 10%		9.10	8.95	8.90	9.10	7.90	8.79	9.67	9.37	9.22	9.72	8.50	9.29
Removing 20%		9.60	9.37	9.35	8.75	8.00	9.01	10.00	9.85	9.70	10.23	8.50	9.66
Removing 30%		8.70	8.57	8.50	8.82	7.95	8.51	9.05	8.95	8.85	9.20	8.57	8.92
Control		8.25	8.10	8.00	8.40	7.72	8.09	8.62	8.72	8.52	8.82	8.08	8.55
Mean (C)		8.91	8.75	8.69	8.77	7.89	----	9.33	9.22	9.07	9.49	8.41	----

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.21	0.29	0.33	0.41	0.46	0.65	0.93
Season 2013/2014	0.28	0.40	0.45	0.56	0.63	0.89	1.26

As for the effect of pruning, Shaban [7] found that moderate pruning significantly increased weight of Zebda mango fruit comparing with the control. Meanwhile, severe pruning gave slight effect on fruit weight; this may be due to increasing number of fruits per tree under severe pining and consequently gave a negative effect on fruit weight. Also, Asrey *et al*. [24] found that pruning treatments resulted in significantly higher fruit weight and fruit firmness as compared with fruits from un-pruned trees of mango cv. Amrapali. Moreover, Falts [19] found that fruit weight significantly increased with removing of one-third of branch as compared to control of Keitt mango trees.

Regarding effect of N fertilization, Jain [25] found that foliar application of urea at 4% on mango trees at pre-flowering and pea–stages, gave maximum average fruit weight. In addition, Umesh *et al*. [21] mentioned that foliar application of urea at 2.5% to mango trees cv. Amrapali acquired more fruit weight compared with the control. Moreover, Amro *et al*. [22] found that foliar application of Urea at 3% increased fruit weight as compared with control treatment on mango trees cv. Fagri Kalan. Lederman *et al*. [26] found that fruits of Tommy Atkins growing in Brazil harvested at 105 days had achieved a harvesting index with firmness 12.5 inch^2.

Fruit TSS (%): Data in Table (6) clarify the effect of pruning treatments and N fertilization rate on TSS of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Highest significant TSS was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar.

With respect to 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 of fruit TSS.

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

Concerning interaction between type of cultivar and pruning treatments, data showed 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 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 Tommy Atkins mango cultivar 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%

Table 7: Effect of pruning severity and N fertilization rate on fruit acidity (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons.

		Nitrogen Fertilization rate (C)											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	2.30	2.30	2.40	2.20	2.90	2.42	2.17	2.07	2.23	2.10	3.07	2.33
	Removing 20%	2.10	2.20	2.10	1.90	2.80	2.22	1.90	1.90	2.13	1.80	2.90	2.13
	Removing 30%	2.50	2.60	2.50	2.40	3.10	2.62	2.40	2.40	2.50	2.30	3.20	2.56
	Control	2.60	2.70	2.70	2.60	3.17	2.75	2.60	2.70	2.80	2.50	3.50	2.82
Mean (A×C)		2.38	2.45	2.43	2.28	2.99	2.50	2.27	2.27	2.42	2.18	3.17	2.46
Tommy	Removing 10%	2.80	2.90	2.80	2.70	3.50	2.94	2.40	2.60	3.37	2.50	3.20	2.81
	Removing 20%	2.63	2.70	2.83	2.50	3.40	2.81	2.30	2.43	2.50	2.20	3.13	2.51
	Removing 30%	2.90	3.13	3.20	2.87	3.60	3.14	2.70	2.80	2.90	2.80	3.40	2.92
	Control	3.20	3.30	3.43	3.13	3.77	3.37	3.13	3.17	2.90	2.90	3.80	3.18
Mean (A×C)		2.88	3.01	3.07	2.80	3.57	3.07	2.63	2.75	2.92	2.60	3.38	2.86
Removing 10%		2.55	2.60	2.60	2.45	3.20	2.68	2.28	2.33	2.80	2.30	3.13	2.57
Removing 20%		2.37	2.45	2.47	2.20	3.10	2.52	2.10	2.17	2.32	2.00	3.02	2.32
Removing 30%		2.70	2.87	2.85	2.63	3.35	2.88	2.55	2.60	2.70	2.55	3.30	2.74
Control		2.90	3.00	3.07	2.87	3.47	3.06	2.87	2.93	2.85	2.70	3.65	3.00
Means (C)		2.63	2.73	2.75	2.54	3.28	----	2.45	2.51	2.67	2.39	3.28	----

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.24	0.35	0.39	0.49	0.55	0.77	1.09
Season 2013/2014	0.29	0.41	0.46	0.58	0.65	0.92	1.30

of vegetative growth with N fertilization rate (50+20+30) in the first season, removing 20% of vegetative growth with N fertilization rate (50+0+50) in the second season, while control either N fertilization or pruning treatments resulted in significantly the lowest.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest.

Fruit Acidity (%): Data in Table (7) showed the effect of pruning treatments and N fertilization rate on acidity of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

Least significant acidity was obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar.

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

Regarding N fertilization rate, the lowest 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 highest fruit acidity.

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

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 lowest values, followed by N fertilization rate (50+20+30), whereas Tommy Atkins mango cultivar under N fertilization control produced significantly the highest fruit acidity.

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

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the lowest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the highest fruit acidity.

Table 8: Effect of pruning severity and N fertilization rate on fruit total sugars (%) of Keitt and Tommy mango cultivars during 2013 and 2014 seasons

		Nitrogen Fertilization rate (C)											
		Season 2012/ 2013						Season 2013/2014					
Cultivar (A)	Pruning (B)	(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%	7.40	7.50	7.40	7.50	6.40	7.24	7.50	7.80	7.40	7.60	6.57	7.37
	Removing 20%	7.77	7.70	7.60	7.90	6.53	7.50	8.13	7.90	7.80	8.20	6.83	7.77
	Removing 30%	7.20	7.10	6.83	7.30	6.13	6.91	7.40	7.23	7.13	7.17	6.40	7.07
	Control	6.80	6.77	6.70	6.93	5.90	6.62	7.10	7.20	6.87	6.80	6.13	6.82
Mean (A×C)		7.29	7.27	7.13	7.41	6.24	7.07	7.53	7.53	7.30	7.44	6.48	7.26
Tommy	Removing 10%	6.50	6.20	6.30	6.30	5.50	6.16	6.70	6.60	6.50	6.80	5.80	6.48
	Removing 20%	6.70	6.50	6.40	6.80	5.57	6.39	7.13	6.97	6.80	7.20	6.13	6.85
	Removing 30%	6.10	5.90	5.83	6.20	5.40	5.89	6.40	6.30	6.20	6.50	5.70	6.22
	Control	5.70	5.60	5.70	5.80	5.13	5.59	6.20	6.10	5.90	6.10	5.47	5.95
Mean (A×C)		6.25	6.05	6.06	6.28	5.40	6.01	6.61	6.49	6.35	6.65	5.78	6.38
Removing 10%		6.95	6.85	6.85	6.90	5.95	6.70	7.10	7.20	6.95	7.20	6.18	6.93
Removing 20%		7.23	7.10	7.00	7.35	6.05	6.95	7.63	7.43	7.30	7.70	6.48	7.31
Removing 30%		6.65	6.50	6.33	6.75	5.77	6.40	6.90	6.77	6.67	6.83	6.05	6.64
Control		6.25	6.18	6.20	6.37	5.52	6.10	6.65	6.65	6.38	6.45	5.80	6.39
Mean (C)		6.77	6.66	6.60	6.84	5.82	----	7.07	7.01	6.83	7.05	6.13	---

LSD at 5% for	Cultivar (A)	Pruning Severity (B)	Nitrogen Fertilization Rate (C)	A×B	A×C	B×C	A×B×C
Season 2012/2013	0.38	0.54	0.60	0.76	0.85	1.21	1.70
Season 2013/2014	0.33	0.47	0.52	0.66	0.74	1.04	1.47

Total Sugars: Data in Table (8) showed the effect of pruning treatments and N fertilization rate on total sugars of Keitt and Tommy Atkins mango cultivars during 2013 and 2014 seasons.

The highest significant total sugars were obtained with Keitt mango cultivar as compared to Tommy Atkins mango cultivar.

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

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 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 total sugars.

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) with insignificant between them, whereas Tommy Atkins mango cultivar under N fertilization control produced significantly the lowest values.

Regarding interaction between type of pruning treatments and N fertilization rate, data showed that removing 20% of vegetative growth with N fertilization rate (50+0+50) induced significantly the highest values, followed 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 total sugars.

Concerning interaction among type of cultivar, pruning treatments and N fertilization rate, data showed that Keitt mango cultivar with removing 20% of vegetative growth under N fertilization rate (50+0+50) induced significantly the highest values, whereas Tommy Atkins cultivar under control treatments either N fertilization or pruning treatments resulted in significantly the lowest total sugars.

These results are in harmony with those obtained by Rakha [17] found that Kent mango cv. recorded the highest percentage of total soluble solids and total sugars while total acidity was the lowest followed by Keitt mango cv., while Tommy Atkins mango cv. recorded the lowest percentage.

As for the effect of pruning, Bamini *et al*. [27] found that light pruning resulted in higher total soluble solids and total sugars of Neelum mango trees. Also, Kumar *et al.* [28] found that severely pruned increased total soluble solids and total sugars of 'Amrapali', 'Mallika' and 'Dashehari' mango trees.

In addition, Asrey *et al*. [24] found that pruning treatments resulted in significantly higher total soluble solids and lower titratable acidity as compared with fruits

from un-pruned trees of Amrapali cv. mango. Moreover, Falts [19] found that removing of one-third of Kitt mango branch significantly decreased total acidity and increased total sugars. Regarding effect of N fertilization, Shah *et al*. [29] found that nitrogen fertilization in April increased TSS and decreased fruit acidity of mango cv. Dusehri. In addition, Amro *et al*. [22] found that foliar application of Urea at 3% increased fruit TSS, total sugars and decreased fruit acidity of mango cv. Fagri Kalan.

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